4.0 Preliminary Review of the Affected Environment, Potentially Significant Environmental Impacts, & Mitigation Measures for the Proposed Alternatives

The PDEIS discusses known information regarding the affected environment, potentially significant impacts and mitigation measures for the proposed alternatives.

The DEIS will also provide analysis of the affected environment, potentially significant impacts and mitigation measures, but will be specific to each of the final alternatives, including the preferred alternative, and have the benefit of input from public comment on the PDEIS. Although the PDEIS will provide a preliminary look at cumulative affects and unavoidable adverse impacts, these will be more fully developed specific to the preferred alternative in the DEIS.

4.1 Affected Environment – Existing Conditions[1]

Natural Environment (4.1.1)

EARTH (4.1.1.1)

Topography and Relief

The Lake Whatcom Landscape Management Planning Area (located in the North Cascades Physiographic Province) consists of two north-south trending ridges, separated by a basin, in which Lake Whatcom is situated. Lookout Mountain is located west of Lake Whatcom, Stewart Mountain is located to the east, and Anderson Mountain is located to the southeast. An east-west valley that extends from Lake Whatcom to Mirror Lake separates Anderson and Stewart mountains.

There is a total of 3,057 feet of relief in the area, from an elevation of 307 feet at the surface of Lake Whatcom to an elevation of 3,364 feet atop Anderson Mountain, based on US Geological Survey topographic mapping. The general elevations of ridges on Stewart Mountain and Anderson Mountain are approximately 3,000 feet. Lookout Mountain is somewhat shorter, with a summit elevation of 2,677 feet.

Topography within the area is complex. There are three general physiographic characteristics within the area. North of Lake Whatcom, and southwest of Lake Whatcom to an irregular line that extends approximately from Chuckanut Creek on the west to the Sudden Valley Golf and Country Club on the east, the terrain is relatively gentle, with slopes inclined at approximately 20 percent or less. To the

[1] Each analyst worked independently, often accessing different GIS and other data sources. As a result, percentages and acreages of different forest types and other elements may vary from section to section. However, the general patterns should be similar and accurate.

south, on Lookout Mountain, and east and northeast of Lake Whatcom, the terrain is steeper and more complex, with planar to convex slopes inclined at approximately 30 to 40 percent, truncated by deeply-incised stream channels, with channel walls generally inclined more than 50 percent, in most areas at 70 percent or steeper. Slopes within the incised stream channels are planar to complex, and closely follow structural patterns in the underlying rock. Southeast of Blue Canyon on Stewart Mountain, and southeast of Lake Whatcom on Anderson Mountain, the terrain consists of complex slopes, with planar to convex portions inclined at 20 to 30 percent (locally 60 to 70 percent), separated by steeper slope areas inclined more than 60 percent (generally 80 to 100 percent). Like the areas to the north and west, deeply incised channels also truncate this area, with channel walls inclined at more than 50 percent, generally 70 to 90 percent.

Geologic Setting

The Lake Whatcom Landscape Planning Area is underlain by metasedimentary rock and low-grade metamorphic rock that were deposited as oceanic sediments, recrystallized under heat and pressure, and then stacked by thrust faulting (likely subduction), to form what has been designated the Darrington Phyllite (Lapen, 2000). Metamorphic rock has been uplifted, eroded, and then buried in local basins by coarse-grained sediments, which were subsequently lithified, folded and faulted to form the Chuckanut Formation.

The Puget Sound region has been subjected to erosion and deposition by glacial processes during the last one million years. The most recent glaciation (referred to as the Vashon stade of the Fraser glaciation), ended about 10,500 years ago. Vashon glacial processes formed area landforms, including the valley occupied by Lake Whatcom, and Reed and Cain Lakes, as well as the east-west valley extending from Lake Whatcom to Mirror Lake. Glacial erosion removed the Chuckanut sedimentary strata and exposed the underlying metamorphic rocks from Blue Canyon southward, and Reed and Cain Lakes eastward. Glacial outwash covers the underlying rock north of Lake Whatcom between Stewart and Squallicum Mountains, south of Lake Whatcom in the vicinity of Reed and Cain Lakes, and along the floor of the outwash channel between Mirror Lake and the south end of Lake Whatcom.

Soil and Rock Characteristics

Rock Units:

The Darrington Phyllite is intensely foliated, and is comprised primarily of microscopic-sized mica grains. Because of the platy structure and relative softness of the mica, the rock is relatively weak. The strength characteristics are directional, with the weakest direction parallel to foliation. The phyllite is primarily a slope-forming rock unit.

The Chuckanut Formation in the area is subdivided into two members, the Padden Member and the Bellingham Bay Member. The Padden Member is comprised of light olive gray to pale yellow brown, thickly bedded sandstone and conglomerate, with mudstone and associated coal interbeds. The sandstone is well-bedded, in some locations cross-bedded. The mudstone is commonly massive to thinly laminated. Sandstone and conglomerate layers (as much as 150 feet thick) alternate with mudstone layers. The Padden Member underlies the gentle topography described above located north of Chuckanut Creek and the Sudden Valley Golf and Country Club.

In the project area, the Bellingham Bay Member underlies and is situated south and east of the Padden Member. The Bellingham Bay Member consists of yellow-gray to gray coarse sandstone, multicolored conglomerate, and blue-gray to gray mudstone. The strata are coarsely bedded at the base of the unit; beds thin upwards towards the top of the formation. The Bellingham Bay Member forms relatively steeper slopes and cliffs than the overlying strata. The steeper topography reflects changes in strength characteristics between relatively strong, thick sandstone and conglomerate layers with weaker, finely laminated mudstone (Lapen, 2000). The geology of the Whatcom Lake area is shown on the Geology Map 7, Appendix C.

Soils: Soils in the area are primarily sand, gravel, and non-plastic fines, derived from the weathering of rock and various slope processes. In the area underlain by phyllite, the soils consist of mica platelets, which are fine-grained to sand-sized, with occasional larger rock clasts. Although the soil is non-plastic, the platy particle characteristic results in much lower internal frictional characteristics than other, similar non-plastic soils. Soil depths are commonly less than five feet deep, except for landslide deposits, which may be up to several 10s of feet deep. Soils in the area underlain by Chuckanut strata are coarse-grained, and consist primarily of sand, and sand with gravel. Soil depths range from a few inches on steep slopes (in those locations where soil is present) to more than 10 feet in local depressions, slope movement features, and in alluvial fans at the mouths of drainages.

Glaciolacustrine, glaciofluvial and glaciomarine deposits are located along the valley floors north, south, and east of Lake Whatcom. These deposits range from silt and silty sand to gravel. Organic silt deposits and peat are located along the valley floor between Lake Whatcom and Mirror Lake (US Department of Agriculture, Soil Conservation Service, 1992).

<u>Geologic Processes</u>

Surficial Geologic Processes - General

Glaciation eroded steep slopes within the planning area, which, when glacial ice receded, no longer were supported. Slopes underlain by the weaker rock units, particularly those underlain by phyllite, collapsed after support was removed. Large-scale slope movement features, primarily resulting from block glide and slump-earthflow processes (Varnes, 1978) in both soil and rock, developed along the valley walls. These processes reestablished large-scale equilibrium, although smaller-scale slope processes occur sporadically, in response to climatic cycles and land management activities.

Streams have eroded deep, steep-walled channels between the ridges and the valley bottoms. The eroded channels are cut in the large slope movement features, as well as in rock and the thin veneer of overlying soil present over much of the area. During intense, long-duration rainstorms and rain-on-snow events, hydrostatic pressures in the cohesionless soil that blankets the channel walls become sufficient to trigger debris flows (Varnes, 1978) within the channels. The flows, which are relatively small at initiation, tend to collect debris as they travel down the channel, including, where present, road fill materials, drainage facilities, and logging debris. During intense storms, the flows often reach alluvial fans situated at the mouths of the channels on the shores of lakes Whatcom and Louise, and Reed and Cain. Several fans within areas now classified as "Alluvial Fan Hazard Areas" under the Whatcom County Critical Areas Ordinance (Title 16, Chapter 16.16.340) are occupied by residences. On January 9 and 10, 1983, six inches of rainfall fell in western Whatcom and Skagit Counties, and likely seven to ten inches of rain fell on snow at higher elevations. Debris flows severely damaged several residential properties situated on alluvial fans. Based on core sampling of lake sediments, this type of slope movement occurs periodically in the area (Orme, 1989).

The lack of overland flow essentially precludes surface erosion in forested areas. Surface erosion is only occurring where the forest duff has been removed along steep channel walls, landslide scarps, roads, and log skid trails.

Surficial Geologic Processes - Mass Wasting Mapping Units:
During a watershed analysis, the Lake Whatcom area was subdivided into six mass wasting map units (MWMU), based on landform, slope shape and gradient, slope movement processes, and the likelihood of sediment delivery to fish habitat and other public resources (Washington Department of Natural Resources, Northwest Region, 1997). Additional mapping by DNR, using the same criteria, delineated similar conditions in the remainder of the Lake Whatcom Landscape Planning Area. The MWMUs with designations of "high" and "moderate" potential hazard rating for forest practice activities were then given designations as Areas of Resource Sensitivity (ARS). The six MWMUs, ARS designations and the slope stability ratings are summarized below.

MWMU 1A: Ancient and Dormant Slump-Earthflow Topography
Low (Stable)

MWMU 1B (ARS 1): Headscarps and Toes of Ancient and Dormant Deep-Seated Landslides Moderate (Unstable)

MWMU 1C (ARS 2): Incised Stream Channels within Deep-Seated Landslides High (Unstable)

MWMU 2 (ARS 3): Incised Stream Channels and Associated Landforms in Phyllite High (Unstable)

MWMU 3: Stable Slopes (Various) Low (Stable)

MWMU 4 (ARS 4): Incised Stream Channels and Associated Landforms in Chuckanut Formation High (Unstable)

Further discussion of these mass-wasting analysis units, along with ARS designations, can be found in Appendix PDEIS-5, "Description of Mass-wasting Mapping Units", and are shown on the Water Types and Mass Wasting Map, Map 6, Appendix C.

Potentially Unstable Slopes

Potentially Unstable Slopes were mapped as part of the landscape planning assessment process, and included slopes steeper than 70 percent in MWMU 1A, MWMU 3, and on slopes adjacent to Cain and Reed Lakes.

Terrain Characteristics

Slopes mapped as being "potentially unstable" are areas that were not included in the previously-mapped ARSs, have not been subjected to slope movement processes, and exhibit a combination of key elements which, when considered in combination, indicate a potential for future slope movement. These include slopes having inclinations steeper than 70 percent, incised stream channels, convergent (concave) headwall areas, slopes at the outside edges of stream meanders, and slopes greater than 65 percent at the toes and scarps of deep-seated landslides. Many of the steep slopes, incised stream channels, and steep headwall areas are located immediately upslope from and adjacent to areas mapped as ARS 2 and ARS 4, and, by definition, appear to meet criteria for inclusion in these areas. Slopes greater than 65 percent at the toes and scarps of deep-seated landslides would, by definition, be included in ARS 1, although the areas mapped as ARS 1 are considered "unstable," even though the slope stability hazard rating is moderate and no significant historic slope movement has occurred.

Slope Movement Processes (Mass Wasting)

No historic slope movement has occurred within this area.

Erosion
Surface erosion is limited to sites where the forest duff has been removed along road cuts and fills, logging skid trails, landslide scarps, and along the active stream channels.

Key Elements Affecting Slope Processes

Terrain and Climatic Effects
Key elements affecting slope movement processes are slopes having inclinations greater than 65 percent at the toes and scarps of deep-seated landslides, other slopes with inclinations greater than 70 percent, and increased ground water pore and hydrostatic pressures, generally during intense rainstorms of long duration or rain-on-snow events. Bends along the stream channels are points of impact from which soil is removed during periods of high flow, undercutting and removing support from the slope.

Human-Caused Effects
To date, timber management has had no adverse effects on areas mapped as potentially unstable slopes. Slope movement processes could be triggered if cut slopes steeper than 1.5H:1V (horizontal/vertical) were constructed in soil, or from local concentration of water on soils on steep slopes.

Seismicity
Western Washington is a seismically active area. Low magnitude earthquakes occur nearly every month and at least four earthquakes over Richter Magnitude 5.0 have occurred within a 50-mile radius of the site over the last 100 years. Recent studies by Brian Atwater (1987) conclude that much larger (perhaps larger than magnitude 8) subduction-zone earthquakes occur periodically along the Washington Coast, the last approximately 300 years ago.

The Uniform Building Code (International Conference of Building Officials, 1997)) classifies the area around the site as a Zone 3 earthquake hazard. The U.S. Geological Survey Earthquake Hazards Program lists a 10 percent probability of occurrence for a probabilistic ground motion value of 23.3 percent of the acceleration of gravity in rock occurring in any 50- year period for the Bellingham area (US Geological Survey, 2001).

AIR (4.1.1.2)

Climate/Air quality

The Lake Whatcom planning area is subject to a maritime climate with cool dry summers and mild wet winters.

One issue raised during scoping was the proposal's potential impact on air quality. While the proposal is not expected to directly affect this resource, DNR chose to discuss this issue briefly.

At present, the Air Quality Index indicates the Bellingham area is rated as "Good," the healthiest rating.

Air quality is regulated by the Federal Clean Air Act, which requires the Environmental Policy Administration to set national Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. An "air quality standard" is an established concentration, exposure time and frequency of occurrence of one or more air contaminants in the ambient air (surrounding outside air) that is not to be exceeded. Ambient air quality standards have been set for six principle pollutants: carbon monoxide, nitrogen dioxide, ozone, lead, particulate matter and sulfur dioxide.

In Whatcom County, air quality is regulated by the Northwest Air Pollution Control Authority, one of seven regional agencies responsible for enforcing air quality laws in Washington. NWAPA regulates over 400 sources of air pollution, including outdoor burning permits, and monitors the Air Quality Index.

DNR's Smoke Management Plan also provides regulatory direction, operating procedures and advisory information regarding the management of smoke and fuels on the forestlands of Washington state. Its purpose is to coordinate and facilitate the statewide regulation of prescribed outdoor burning on lands protected by the DNR and on unimproved, federally managed forestlands and participating tribal lands. The plan is designed to meet the requirements of the Washington Clean Air act.

<u>Wildfire</u>

None of the five alternatives specifically address prescribed fire use. These comments are based on analysis of historical trends in fire use and wildfire occurrence in the general area.

The planning area is classified as fire regime 3 (Hardy, 2000). Historically, mixed severity wildfires occurred in the planning area every thirty-five to one hundred plus years.

Between 1970 and 2000, seven wildfires occurred on state land in the planning area. Fire causes were: incendiary (1), recreation (2), smokers (1), debris burning (2), and logging (1). The largest fire was 0.8 acres. All other fires were no larger than 0.1 acre.

Fires, when they do occur, can affect air quality. Fires produce a variety of pollutants, including particulate matter, carbon monoxide, methane, and nitrogen oxides (EPA 1996).

Silvicultural Burning

No burning permits were issued on state lands in the planning area between 1993 and 2001.

The department has found no evidence to support concerns expressed during scoping that mercury is released during silvicultural burning in northwest Washington. No additional research has been done on this question, since little or no silvicultural burning is expected in the future under the HCP, DNR's Smoke Management Plan, and state and federal clean air regulations.

WATER (4.1.1.3)

More than 90 percent of the trust lands managed by the Department of Natural Resources within the Lake Whatcom Landscape planning area are also within the Lake Whatcom watershed. These trust lands make up nearly half of the uplands that drain into the lake, and they influence most of the perennial streams within the watershed. Based on a water balance calculated for water year 2001 (Matthews *et al.,* 2002), it is estimated that trust lands produced 35 percent of the water flowing into Lake Whatcom. There is a high potential for trust lands to influence the quantity and quality of water in Lake Whatcom.

Commercial forest production is the primary use of trust lands within the Lake Whatcom Landscape planning area. Other uses include or could include special forest products, recreation, mining, oil and gas exploration, and communication sites. However, commercial forestry activities are more pervasive and have the greatest potential for influencing water quantity and quality. The effects of these activities are emphasized in the following discussion.

Surface water quality

Surface water quality of some streams draining trust lands within the Lake Whatcom planning area has been measured to a limited extent. The Institute for Watershed Studies (IWS) at Western Washington University has been monitoring several streams throughout the 1990s to the present (Matthews *et al.*, 2002). Among these, Smith Creek best represents stream conditions not significantly influenced by urban land use. Since most of the Smith Creek watershed is trust forest land, information from Smith Creek will be used to characterize the current condition of water quality in forest streams.

The water quality parameters most likely to be affected by forest management activities on state trust lands in the planning area are sediment, temperature and nutrients (WFPB, 1997). Surface water quality for the proposed alternatives will be evaluated by comparing these parameters.

Ecology has identified dissolved oxygen, mercury, PCBs, and bacteria as water quality issues in Lake Whatcom. PCBs and mercury have been found in fish tissue. Low dissolved oxygen levels have been reported for Lake Whatcom, while high levels of bacteria have been reported for several tributaries to Lake Whatcom. Ecology has initiated a total maximum daily load (TMDL) study to address these issues. However, Ecology has stated that state trust lands are not expected to be a significant part of the problem, and that the likelihood of imposing additional controls on pollution from commercial forestland is remote. (Ecology letter; 2001; see Appendix D, PDEIS-7.)

Sediments: Sediment occurs naturally in all forest streams. In the Lake Whatcom planning area, slope creep and mass wasting were identified as the primary natural processes that deliver sediment to stream channels (WDNR, 1997a). Background levels of annual sediment yield for Smith Creek was estimated by the Lake Whatcom Watershed Analysis (WDNR, 1997a) to be about 40 metric tons/ km^2.

Currently sediment yields are above background levels because of past management activities. Runoff from forest roads is delivering sediment to surface waters. It was estimated that roads in Smith Creek contributed additional sediment equivalent to 13 percent of background levels (WDNR, 1997a). However, DNR has done work to reduce sediments entering streams from roads since the Watershed Analysis was published. The quoted 13% above background sediment levels has hopefully been reduced. The HCP, new Forest Practices Rules, and Watershed Analysis prescriptions are all designed to improve fish habitat; some actions under these will have immediate affects while others, particularly those requiring time for trees to grow, will take longer.

Estimates for other sub-basins varied according to the amount of roads and road surface conditions. On a volume basis, however, accelerated mass wasting has contributed the most sediment. Based on several analyses, Grizzel (2001) estimated that sediment yields over the Lake Whatcom Planning Area are 2.4 times greater than background levels. As much as 95 percent of this increase is attributed to accelerated mass-wasting. Interestingly, more than half of the volume was delivered during and shortly after one event in January 1983. Orphaned forest roads (constructed and used prior to 1974) were the primary triggering mechanism for most of the landslides that occurred during this event (WDNR, 1997a).

Temperature: Forests influence surface water temperatures by providing shade. The 1997 Watershed Analysis determined that 75 percent of the forest stream miles within the Lake Whatcom Planning Area met shade targets for maintaining temperatures of Class AA streams (WDNR, 1997a). Maximum temperatures for

Class AA streams must be at or below 16.3 C^{o}. Recent temperature measurements in Smith Creek are below the maximum. However, the measurements are only taken once in February and once in July (Matthews *et al.*, 2002). Annual maximum temperature often occurs in August. Daily temperature measurements taken in 1990 did show that the maximum temperatures in Smith Creek and five other streams exceeded the water quality standard (Matthews *et al.*, 2002). One explanation given for this was that the channel scour and bank erosion caused by debris torrents associated with the January, 1983 storm event delayed the recovery of shade levels (WDNR, 1997a).

Nutrients: Nutrient concentrations in most Pacific Northwest forest streams are quite low, and almost all the forest streams in the Lake Whatcom Planning Area are no exception. Measurements of nitrogen in the form of nitrate, nitrite, and ammonium as well as soluble and total phosphorus have consistently been low (Matthews *et al.*, 2002; Ryan, 1984). An exception is Wildwood Creek where nitrate concentrations were found to be consistently higher than in other measured streams. One explanation given for this is the influence of red alder (*Alnus rubra*) in riparian areas (WSPP, 2000). Red alder is capable of fixing atmospheric nitrogen and improving soil fertility (Fowells, 1965). Red alder leaf litter also is high in nitrogen.

In addition to nitrogen fixation by some species and deposition of leaf litter, forest vegetation influences seasonal changes in nitrogen concentrations of surface waters in the Lake Whatcom Planning Area. During the winter there is a reduction in nutrient uptake by plants. This combined with higher precipitation causes higher rates of leaching the more soluble forms of nitrogen.

Forest management activities on trust lands within the Lake Whatcom planning area also have influenced nutrient levels in surface waters. Timber harvest reduces nutrient uptake, and for a few years more soluble nitrogen is available for leaching. However, the elevated concentrations usually do not degrade the water quality of nutrient-poor streams (Dissmeyer, 2000). Direct introduction of nitrogen through forest fertilization has affected concentrations of nitrate, nitrite, and ammonia in the past. In the early 1980s DNR monitored the effects of a fertilization project. While there were some increases following application, concentrations went to background levels within a few days, and water quality was not degraded (Ryan, 1984).

DNR has not fertilized with phosphorus operationally. Phosphorus is less soluble than nitrogen, and it is not readily leached from the soil. Consequently forest management activities do not significantly affect concentrations of soluble phosphorus (Dissmeyer, 2000). Most of the phosphorus entering surface waters is attached to sediment. Therefore those activities that have a potential for increasing surface erosion or mass wasting are the most likely to influence total phosphorus loading. Measurements of total phosphorus in Smith Creek showed levels to increase by as much as ten times above background when the creek was influenced by a mass wasting event (Walker *et al.*, 1992).

Surface water quantity

The Lake Whatcom planning area is subject to a maritime climate with cool, dry summers and mild, wet winters. The topographic relief of the area causes orographic lifting of moist air masses coming off the Pacific Ocean. As a result, the area distribution of average annual precipitation varies from approximately 45 inches at the north lake level to as much as 75 inches at higher elevations (WDNR, 1997a). Rainfall is the dominant form of precipitation for most of the area.

Very little of the rainfall and snow melt in the area becomes overland flow without first infiltrating into the permeable, coarse-grained soils blanketing the area. Water emerges from springs and seeps throughout the area, and feeds the many streams in the area.

The hydrographs of forest streams follow seasonal precipitation patterns with low flows occurring in the summer and high-flow responses to storm events in the fall and winter. Sometimes storm flows are augmented by snowmelt from higher elevations during relatively warm winter storms. These events are commonly called rain-on-snow, and are often associated with extreme peak flows.

The 2001 water year water balance estimated for Lake Whatcom by IWS did not distinguish between ground and surface water delivered to the lake from the uplands (Matthews *et al.,* 2002). Using streamflow measurements from Austin and Smith creeks, annual surface water production was estimated on a per unit area basis. From this estimate it was determined that 96 percent of the water production from trust lands is delivered to Lake Whatcom as surface water.

Forest management activities can affect annual water production (water yield). Timber harvest has the greatest effect on water yield. Forest vegetation intercepts a portion of precipitation before it reaches the forest soil, and it extracts water from the soil and releases it to the atmosphere through the transpiration process. Transpiration and interception are reduced following timber harvest, and more water is available to be transported to stream channels. The greatest increases occur in the spring and fall when soil moisture levels have more of an influence on the water balance. Water yields from harvested sites gradually recover to pre-harvest levels within 20 to 40 years, depending on site productivity.

Peak flows can be affected by management activities in several different ways. Higher soil moisture levels on harvested sites reduce the amount of precipitation required to recharge soil water-holding capacity at the end of the growing season. Therefore, more of the precipitation from early fall storms becomes streamflow causing higher peaks than would be expected under fully forested conditions.

Generally, these peak flows are the lower magnitude responses that do not cause flooding or channel changes (Rothacher, 1973; Harr *et al.*, 1975). Activities that cause overland flow and interrupt the normal subsurface transport of water to stream channels, such as road construction, can increase peak flows because of faster delivery times. However, the proportion of a watershed that would have to be in roads before significant changes occur is much greater than what currently is present on trust lands.

The activity with the highest potential for increasing peak flows associated with flooding and channel change is timber harvesting at elevations from 1,700 to 2,900 feet. At these elevations, timber removal encourages longer retention of transient snowpacks and increases the rate of melt during rain-on-snow storm events. Currently, none of the forested watersheds within the Lake Whatcom planning area have significant increases in peak flows (WDNR, 1997a). However, Olsen and Smith Creek have been given a moderate peak flow sensitivity rating in the watershed analysis for future conditions (i.e., percent of forest hydrologically mature).

<u>Groundwater quality</u>

The term "groundwater" is used here to mean any water that is stored or transported below the ground surface. This includes water perched on a shallow, impermeable layer or bedrock as well as water stored in a deep aquifer. Forest soils normally have high infiltration capacities, and overland flow seldom occurs (Anderson *et al.*, 1976). Water is normally transported to stream channels by subsurface flow. Therefore, almost all the water production from trust lands within the Lake Whatcom planning area was groundwater at some time before reaching the lake. Because such a large proportion (96 percent) of the water delivered to Lake Whatcom is streamflow, the discussion under surface water quality pertaining to nutrients also applies to groundwater quality.

<u>Groundwater quantity</u>

Water readily infiltrates into the coarse-grained soil covering most of the Lake Whatcom Landscape planning area. The water migrates downward to the rock line, and then flows downward, along the top of rock, to where it emerges from seeps and springs situated along the steeper slopes. Some water migrates into planar separations in the underlying rock, and either flows downward, where it is stored, or migrates laterally along the planar separations to seeps at the ground surface. Seepage at the upper ends of many drainages occurs intermittently, following extended periods of rainfall and snowmelt. Year-round seepage farther down gradient supplies water to Type 2, 3, and 4 streams throughout the area.

Groundwater also infiltrates into the various glacial deposits beneath the valley floors. This water either remains beneath the ground surface, or migrates laterally into Lake Whatcom or one of the other lakes located in the valley.

Forest management activities influence the quantity of groundwater in the same way as they affect surface water quantity. One exception is any activity, such as road construction, that creates an impermeable or semi-impermeable surface. This condition will cause overland flow, and the quantity of groundwater is locally decreased. Given the road density on trust forestlands within the Lake Whatcom planning area, most of overland flow will be returned to subsurface flow except where road drainage is directed into a stream channel. Therefore, the total quantity of groundwater under current conditions is not significantly different than for undisturbed conditions.

Public water supply

Lake Whatcom is the municipal water supply for the City of Bellingham and Water District 10. Water is also extracted from Brannian Creek for the Brannian fish hatchery. Vulnerability ratings for sediment, water temperature, peak flows, low flows, and nutrient input were determined for each of these water supplies (WDNR, 1997a). The ratings for the municipal water supplies were low for all parameters except for the high rating given to nutrient input. The Brannian Creek water supply had high vulnerability ratings for all parameters.

Although nutrient concentrations are low in surface waters flowing into Lake Whatcom from trust forestlands, annual loading rates could be increased if water yields are significantly increased and concentrations remain constant. Input of total phosphorus will increase if sediment loads increase. Forest management activities could influence all the parameters in Brannian Creek as described under the surface water quality and surface water quantity sections. However, the effects from trust land management would probably be minimal because only a small portion of the watershed is in state ownership.

In addition, the state's drinking water regulations require water systems using surface water, such as Lake Whatcom, develop a source water protection plan. The Source Water Protection Plan for Lake Whatcom prepared by the City of Bellingham and Whatcom County Water district #10 identifies a number of activities, conditions, and land use practices within the watershed that have or could have an adverse impact on water quality. The Department of Health reports that very few of the potential contaminant sources identified in this protection plan for Lake Whatcom could originate from state forestlands or DNR's activities. The water treatment facilities located on Lake Whatcom have been designed and constructed to address potential contaminant sources, including activities historically associated with state forestlands. (DOH letter, 2001; See Appendix D, PDEIS-8.)

PLANTS AND ANIMALS (4.1.1.4)

Forest Vegetation: Upland, Riparian, Wetland

Plant Species Composition, Structure and Site Quality

Forest stands can be described in terms of plant species composition, structure and site quality. Species composition refers to the variety or species richness of plants found within a given stand. Structure can be described as the variety of the vertical and horizontal arrangement of trees, shrubs, forbs, grasses, mosses etc. and also snags, dead and down material, and conditions on the forest floor. Site quality refers to a combination of factors (soil composition, depth, and fertility and climatic conditions) that influence plant growth. Site productivity in Lake Whatcom Landscape is variable from poor to fairly good; an overall characterization would be moderate site quality. Sixty-eight percent of the watershed is forested.

Biological Diversity and Mature Forests

Biological diversity has several aspects, which include the number (variety) and abundance (evenness) of species present in a stand; the genetic variation among individuals within a species; the variation in species and their abundance among stands and across landscapes; and the variation in presence and structure of canopy layers within and between stands and across landscapes (Curtis and others 1998). Different species tend to be associated with different forest stand conditions. In order to provide and maintain habitat for a wide variety of wildlife and plant species, a balanced distribution of forest stand structures and developmental stages needs to be developed and maintained across landscapes. Mature forest (forest that has mature forest characteristics such as large snags, large fallen trees, canopy gaps, and structural diversity) includes the balance of stand structures and developmental stages necessary to support such a broad variety of species.

One of today's challenges in managing a commercial forest is to learn how to provide similar support to native plant and animal species in the mosaic of forest patterns that emerge from management activities. This is currently a subject of study and great debate. For the purposes of this EIS, the alternatives will be compared to a natural forest, with the ideal being a highly mature forest that, through naturally functioning, creates openings and all the other seral stages. These patches are generally smaller in size and closer in proximity to one another than in a commercial forest. Only Alternative 5 actually sets recreating a natural forest as the management goal.

Characteristics of forest stands important to some wildlife species include: the presence of large live trees; a layered canopy structure which is composed of understory trees and shrubs of varying ages and sizes; a variety of plant species;

an abundance of large snags and live trees with cavities or other attributes needed for nesting, roosting and foraging; presence of large woody debris on the forest floor; and canopy gaps that allow a diverse, well-developed, but patchy understory (Franklin, 1997). These characteristics of forest structure commonly develop at advanced ages in natural stands; however, their development may be significantly accelerated in younger stands by appropriate silvicultural treatments (Carey 1996). Achieving these forest stand characteristics throughout the landscape is important for maintaining biological diversity.

Approximately 68 percent of the Lake Whatcom watershed area is forested. The majority of the planning area is located in the Western Hemlock Forest Zone (Franklin and Dryness 1973), with conifer stands dominated by Douglas-fir (*Pseudotsuga menziesii)* and western hemlock (*Tsuga heterophylla*), with a western redcedar (*Thuja plicata*) component in many areas. Hardwood dominated stands are common along riparian areas and some of the lower elevations. These are composed of red alder (*Alnus rubra)*, black cottonwood (*Populus trichocarpa)*, and bigleaf maple (*Acer macrophyllum)*. Understory vegetation is dominated by sword fern *(Polystichum munitum)* and huckleberries (*Vaccinium* spp.). Salmonberry *(Rubus spectabilis)* is common in riparian zones. Dwarf Oregon grape (*Berberis nervosa)* is common on drier sites.

The specific species composition and stand density of forest stands are strongly influenced by both natural processes and management activities.

Historical Influences on Today's Forest Vegetation

Settlement by Euro-Americans within the Lake Whatcom watershed began during the 1870s. Extensive railroad logging during the 1880s-1920s is primarily responsible for the forest development stages currently found in the planning area. Logging within the watershed accelerated after the completion of a railway in 1892 connecting the south end of Lake Whatcom to Bellingham Bay along the eastern shore. Logging generally began at the southeastern end of the lake and proceeded northwesterly. By the time of World War I, most of the original forests around the lake were harvested. This suggests that initial logging reached its peak during the period 1890-1915. Timber harvest activities were less frequent from 1920 through the 1970s, due to the younger forest stands present after harvest of the original forests.

Significant timber harvest activities resumed in the 1980s as stands came of merchantable age and size. During this time, population growth in the county and residential development in the watershed also increased. This reduced the amount of forestland present today and influenced the pattern of distribution across the landscape. Public concern about the affects of timber harvesting on water quality, aesthetics and wildlife habitat also increased. An effort to transfer lands in the watershed to the state was initiated. In 1992, through a land exchange with

Trillium Corporation, the state became the majority forest landowner, adding nearly 5,000 acres to state ownership.

Primary Tree Species[2]

Based on DNR forest inventory, Douglas-fir dominated stands represent approximately 51 percent of the forested stands within the planning area. A general breakdown of DNR-managed forestlands by dominant species is shown below:

Dominant species:	Percent of state trust lands (approximate)
Douglas-fir	51 percent
Red alder	22 percent
Western hemlock	20 percent
Western redcedar	5 percent
Small areas of bigleaf maple	2 percent
Pacific silver fir	<1 percent

Stand Conditions and Developmental Stages

Stands are very dynamic, changing over time and progressing through different stages as trees become established, grow, and eventually die. In young stands, changes occur relatively rapidly and are readily apparent, but changes are more subtle and difficult to detect in older stands. Criteria used for delineating stand conditions in this document are the same as those used in the DNR Final Habitat Conservation Plan (HCP Sec.IV, p.180). These stand development stages use forest stand age as a surrogate for certain structural characteristics of stands on the landscape.

Open condition (0 - 10 years):
Earliest seral stage. Overstory has been removed. Dominated by herbs and shrubs with some young conifer and deciduous trees present.

Regeneration (10-20 years):
Primarily shrubs and saplings. Branches beginning to intertwine. Dense canopies from ground-level upwards.

Pole (20-40 years):
Early stages of stem-exclusion (i.e., young trees dying out due to competition for sunlight and soil nutrients). Young trees are closely spaced and numerous. Little understory (i.e., small seedlings, brush and groundcover). Limited self-pruning; and insufficient canopy lift to allow larger birds to penetrate.

[2] FRIS inventory data was assessed to determine primary tree species composition within the planning area, as determined by the highest basal area for tree species present within a given forest inventory unit (FIU).

Closed (40-70 years):
Have undergone some stem exclusion and competition mortality. Have achieved some canopy lift from self-pruning. Have well developed, deep canopies. Lacks complex structural characteristics of older forests.

Complex (70+ years):
Stocked with large trees with a variety of diameters and heights evident. Mortality within the stand (i.e., residual trees, snags and logs) provides cavities in standing snags, downed logs, and deformities in standing live trees. Large horizontal branches. A complex canopy with conifer establishment occurring under openings in the canopy.

Fully Functional as Mature Forest *(150+ years)*
A subset of "complex," but more mature and structurally complex. It should be noted that the label "fully functional" for forests more than 150 years of age could be a bit misleading, in that a stand at 150 years is just beginning to exhibit mature characteristics (popularly known as "old growth" characteristics). Its rate of growth has slowed, and it is *beginning* to form canopy gaps, large snags and down woody debris, layered structure and structural diversity. However, it may be another 50 to100 years before it has fully mature structure and function.

Also, the use of "fully functional" for the mature forest does not mean that other stages are non-functional; they simply don't, on their own, provide the range of complexity that is in fully functional mature forest, which itself contains small patches of different seral stages that are closely and intricately interspersed in the mature forest.

Current Forest Vegetation Conditions on State Trust Lands[3]

Mid-seral forests in the "closed" condition currently dominate state lands within the planning area. Approximately 68 percent of the planning area is composed of forested stands between 30-80 years old. Of these acres, approximately 5,855 acres contain stands between 61-80 years old, which is the typical rotation age on actively managed state lands.

When broken down by stand development stages used in the HCP[4], state trust lands are composed of the approximate percentages per stage shown in Table 8.

[3] For this assessment of the affected area, stand conditions were identified and assessed using DNR=s Forest Resource Inventory System (FRIS) database.
[4] (NOTE: The acreages listed in the following paragraph reflect recent updates to the land ownership GIS POCA layer. None of the other acreages listed in this section reflect these updates).

Table 8: Percent of total trust lands in each stand development stage.

Percent	Age
13	0-20 years old (“open” + “regeneration”)
5	21-40 years old (“pole”)
50	41-70 years old (“closed”)
31	Greater than 70 years old (“complex” + “fully functional” mature forest)
Less than 4 percent of the planning area is over age 100 years.	
Less than 1 percent of the planning area is 121-200 years old.	
About 1 percent of the DNR “forestland” within the planning area is permanently non-forested (power right-of-way, communication sites etc.) and could be included in the “open” condition.	

Snags and Down, Dead Trees

Dead trees in the forest in the form of snags and down woody debris provide a wide variety of important habitat[5] and ecosystem functions. Sometimes snags and down logs are legacies from pre-disturbance communities which are inherited by the post disturbance forest, providing an important structural link for populations of invertebrates and fungi to the current community (Hayes, 2001). In other situations, they may be due to mortality from within the current stand.

Snags (defined as dead or partially dead trees), and down woody debris (defined as any woody material that is dead and lying on the forest floor) contribute substantial vertical and horizontal diversity to forest structure. Both snags and down logs play vital roles in the maintenance of long-term productivity through nutrient cycling, immobilization and mineralization, soil development, productivity and retention, water retention and nitrogen fixation. Snags and down wood also have a role in the life cycle of mycorrhizal fungi, which are extremely important in nutrient cycling for tree growth. A great many wildlife species depend on snags and down wood, and in turn contribute to the functioning of the forest through transformation of energy and cycling of nutrients in wood, and mycorrhizal fungus spore dispersal (Rose, et. al. 2001).

Snag sizes and densities derived from DNR’s forest inventory data were assessed for the planning area, showing a relatively low density of snags in most areas. It is assumed that timber harvest activity in the planning area has reduced the abundance and distribution of snags across the landscape.

Wetlands

Wetlands are areas where water saturates or floods the soils for long enough during the growing season to develop anaerobic conditions, excluding plants that are not adapted to life in saturated soils. Wetland habitats include freshwater marshes, swamps, bogs, seeps, wet meadows, and shallow ponds. Wetlands can be forested, or dominated by shrubs, herbs, mosses, grasses or grass-like plants.

[5] See section titled “Animals”.

Riparian areas are those areas associated with streams, including the stream itself, and the surrounding uplands that have a direct influence on the riparian ecosystem.

Wetlands are characterized by a high diversity, density, and productivity of both plant and animal species. Wetlands and riparian areas provide some of the most important fish and wildlife habitat in forestlands. Many wetlands have rates of primary productivity that are among the highest in the world (Bigley and Hull, 2001). Wetlands also provide sites for groundwater exchange (recharge at some locations and discharge at others), sediment trapping, water purification, stormwater detention and seasonal streamflow augmentation.

Maintaining the hydrologic functions of wetlands, as well as riparian areas, is essential to maintaining the health and function of the entire aquatic ecosystem and contributes to the health of the upland ecosystem as well.

While streams abound on state-managed lands within the planning area, sizeable wetlands are more rare due to the steep topography of the area. The most significant wetlands occur in the vicinity of Mirror Lake, though most of this wetland complex occurs on private land. There are a few scattered wetlands between 0.25 - 1.0 acre in size on state-managed lands. all of which have buffer protection under current management standards. There are frequent smaller wetlands and wet areas (less than 0.25 acres) located throughout the upland area, primarily associated with folds in the underlying sandstone formations. Wetlands less than 0.25 acres in size are not provided protective buffers under current management practices.

<u>Forest Health: Insects and Disease</u>

Forest health is a condition where biotic and abiotic influences on forests do not threaten management objectives now or in the future (USDA Forest Service, 1993). The most serious forest health problems occur when natural forest dynamics are upset and tree resilience is decreased, allowing damaging agents to flourish. DNR targets specific stands for forest health treatments when insects, disease, adverse weather, or other damaging agents are expected to unacceptably impact the management objectives for a specific site or area and a net benefit could be achieved by using targeted forest health practices. Forest health practices include harvest, thinning, salvage, slash treatment, revegetation with more desirable species, hazardous tree removal, and pesticide application.

The major forest health problems observed or expected to occur in the Lake Whatcom area include insects (Douglas-fir beetle, balsam woolly adelgid, hemlock looper, Douglas-fir pole beetle), animals (bear, mountain beaver), disease (root diseases, needle cast), and weather (water, wind, winter damage, and drought). Most are native. The majority of them typically are not active every year, tend to kill a few trees at a time, affect one tree species, or affect one size class of tree. Native insects and diseases typically do not threaten ecosystem processes, but do impact specific management objectives. Exotic insects or diseases may threaten ecosystem components. Hazardous trees, those likely to fall and damage valuable assets or threaten personal safety, are also a forest health consideration.

Each forest health problem is favored by specific forest structures that can be prevented, mitigated or eliminated through standard forest management practices. For example, the Douglas-fir beetle breeds in freshly fallen logs. If a large quantity of fresh logs is available, such as after a major windstorm, the insects breed easily. When they emerge the following year, high beetle populations are capable of attacking and killing large, healthy Douglas-fir trees. Rapid salvage of large quantities of freshly fallen Douglas-fir logs is desirable to recover the value of the logs plus prevent beetle population build-up and additional damage to living trees.

In portions of the watershed where more coarse woody debris is desired, a more contemplative approach may be taken. Smaller quantities of blowdown might be left in place and monitored closely; logs might be salvaged only if high beetle populations were observed to be developing; a Douglas-fir beetle anti-aggregant pheromone might be applied to keep the beetles away from the logs. The choice of silvicultural tool (salvage, partial or delayed salvage, monitoring, pheromone treatment) depends on the management objectives for the area, the degree to which those objectives are threatened by the specific problem, and the cost of implementing silvicultural measures.

None of these problems currently imminently threatens the watershed as a whole. Some may currently be significant problems on specific sites. The landscape objectives (common to all the alternatives) that are most likely to be affected by forest insects and diseases include:

#3: *Protect and restore riparian and wetland habitat to sustain healthy native aquatic, wetland, and riparian ecosystems.* Its exact role in the ecosystem is unclear, but Sitka spruce is likely a diminished part of this ecosystem. Active planting and culturing of seedlings that will resist white pine weevil damage could restore Sitka spruce to areas it once occupied. Forest chemicals can be cost-effective tools for protecting specific resources or achieving specific objectives. They are carefully regulated and used in order to protect water resources and prevent undesirable effects.

#7: *Permanently retain green trees, snags, and down logs to support mature forest functions.* Insects and diseases affect the rate of structural changes in a forest by killing trees, altering growth form, or influencing decay rates. Where specific structures are represented at less than their historic range, insects and diseases can help restore appropriate levels. Management strategies that increase tree vigor can reduce mortality caused by insects and diseases. Sometimes there are trade-offs between the benefits and detriments represented by a given agent. For example: hemlock dwarf mistletoe causes abnormal branch growth, which develops into platforms (good wildlife habitat). However, this disease can be transmitted to adjacent younger hemlocks, slowing their growth sufficiently to prevent them from ever maturing to desirable large sizes.

#12 *Maintain or improve commercial forest productivity and health.* Managing with consideration of specific forest insects and diseases, or the general goal of maintaining tree vigor, reduces the negative impacts of forest insects and diseases, and improves commercial productivity by capturing the value of natural mortality and creating higher value products. Generally regeneration harvests are a necessary tool for addressing forest health problems that require major shifts in species or structures on a site. Thinning can be sufficient to address individual undesirable trees or temporarily improve stand vigor. Current forest practice regulations and management policies affecting DNR, generally do not create sufficiently uniform stands to put the ecosystem at risk of major epizootic diseases associated with off-site monocultures.

#13 *Cultivate higher value commercial forest products.* Some insects are directly associated with higher value products (e.g. pitch moths which potentially infest wounds created by pruning; decay fungi which infect wounds created during partial cutting). Moreover, the effects of all forest insects and diseases become more critical when the resource to be saved represents significant investment. Strategic management of forest trees can significantly improve their resilience and reduce opportunities for insect or disease attack.

#14 *Develop and maintain a transportation network that facilitates commercial management efforts.* This is also beneficial to emergency pest response, particularly when access necessary for survey or rapid tree removal is available.

In some situations, forest insect populations may develop which have the potential to spread from one owner's lands and cause negative effects on adjacent properties. For example, high populations of western hemlock looper, which develop in mature hemlock, have commonly caused defoliation in adjacent conifer plantations. Douglas-fir beetle, which develops high populations in blowdown following windstorms, can then kill healthy mature Douglas-fir in the general area.

Some might question whether there could be indirect positive effects to neighboring lands. For example, the woodpeckers and bats and songbirds which breed and/or have consistent food resources (bark beetles, caterpillars) available on less-intensively-managed portions of state lands will potentially be available to feed on bark beetles and caterpillars on adjacent lands, providing indirect benefit through dampening potential pest outbreaks in the vicinity. There would be a lag between damage being exported to adjacent lands and the movement of damage-controllers, which may reduce the damage intensity or duration, but not prevent it.

Rare and Sensitive Plants

The only records for rare plants within the Lake Whatcom watershed are for two populations of *Lobelia dortmanna* (water lobelia), sighted in the 1930s and 1960s. *Lobelia dortmanna* is an aquatic species, listed as threatened on the Washington State Endangered Species list. The plants were found in shallow water at the shore of Lake Whatcom. One population was in the Agate Bay area, probably on the west shore or just to the west of the bay. The other population was seen on the lakeshore near Reveille Island.

Lobelia dortmanna occurs on sandy bottoms in shallow water of nutrient-poor, softwater lakes (Pederson, 1995). Because of its habitat requirements, it may be sensitive to nutrient inputs and rapid water level fluctuations, but this is undocumented.

Animals

Wildlife Species of Special Interest

Wildlife occurrences for the Lake Whatcom planning area were obtained from the Wildlife Assessment Report for the Lake Whatcom Landscape Plan (Appendix D), and were originally derived from the Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species database, Natural Heritage database, DNR's TRAX data, and personal communications with WDFW Wildlife Biologists (Davison, Caniff, 2001). Many wildlife species use the Lake Whatcom planning area, and known wildlife occurrences are addressed on all ownerships. However, the analysis of impacts to wildlife and wildlife habitat for each of the alternatives is limited to state trust lands within the planning area that are owned by the State of Washington and managed by the Department of Natural Resources.

The bald eagle is the only animal species listed by the U.S. Fish and Wildlife Service (USFWS) that has been documented, and which is likely to still occur, in the Lake Whatcom landscape. Other federally-listed species that may have historically occurred in the landscape but have since been extirpated (due to a variety of causes) are listed below:

Species	**Status**[6]
Northern spotted owl (*Strix occidentalis caurina*)	FT, SE
Marbled murrelet (*Brachyramphus marmoratus*)	FT, ST
Gray wolf (*Canis lupus*)	FE, SE

[6] FE – Federal Endangered, FT – Federal Threatened, FSC – Federal Species of Concern, SE – State Endangered, ST – State Threatened, SC – State Candidate

Grizzly bear (*Ursus arctos*)	FT, SE
Wolverine (*Gulo gulo*)	FSC, SC
Fisher (*Martes pennanti*)	FSC, SE
Marten (*Martes Americana*)	None
Elk (*Cervus elaphus*)	None

Bald eagles have been documented to use portions of the planning area for breeding (there are two known bald eagle nesting territories within the planning area). There are no known winter concentrations of bald eagles within the planning area (i.e., no known major feeding areas or winter communal night roosts). Winter concentrations are usually found to the east of the planning area, in the Samish River drainage.

It may be premature to consider marbled murrelets as a "historical" species within the planning area, but surveys were conducted on 187 acres of potentially suitable habitat in 1997 and 1998, with no murrelet detections. Given what is currently known about the types of stands that active nests have been located in within Washington forests, it is reasonable to assume that the large trees and structures favored by murrelets for nesting are currently lacking within the planning area. However, protocol (Pacific Seabird Group) surveys are being conducted in 2001-2002 on 417 additional acres identified as potentially suitable murrelet habitat by the habitat model that was developed for the North Puget Planning Unit.

It should be noted that, even though Alternatives 3, 4 and 5 would require surveys of other potentially suitable habitat not identified by the model, the results of these surveys are not expected to require a significant change in management approach or in the status of murrelets in the planning area. Therefore, marbled murrelets are not discussed further in the analysis of the alternatives.

Other wildlife species of interest that may occur in the Lake Whatcom planning area are listed below:

Species	Status[7]
Common loon (*Gavia immer*)	SS
Great blue heron (*Ardea herodias*)	SM
Osprey (*Pandion haliaetus*)	SM
Bald eagle (*Haliaetus leucocephalus*)	FT, ST
Northern goshawk (*Accipiter gentilis*)	FSC, SC
Pileated woodpecker (*Dryocopus pileatus*)	SC
Vaux's swift (*Chaetura vauxi*)	SC
Purple martin (*Progne subis*)	SC
Olive-sided flycatcher (*Contopus borealis*)	FSC
Tailed frog (*Ascaphus truei*)	FSC, SM
Townsend's big-eared bat (*Plecotus townsendii*)	FSC, SC
Western toad (*Bufo boreas*)	FSC, SC
Keen's myotis (*Myotis keenii*)	SC
Yuma myotis (*Myotis yumanensis*)	FSC

[7] FE – Federal Endangered, FT – Federal Threatened, FSC – Federal Species of Concern, SE – State Endangered, ST – State Threatened, SC – State Candidate, SM – State Monitor

These species include Species of Concern (State Endangered, Threatened, Sensitive, or Candidate), or species of other interest (State Monitor), according to the Washington Department of Wildlife (WDFW).

Loons have been recorded on Lake Whatcom during winter months, and adult loons with young have been observed on the lake (Eissinger, personal communication, 2001). However, there are no confirmed nests in the WDFW database. Because loons are sensitive to disturbance in the vicinity of nesting areas, it is likely that heavy recreational use of the lake and shoreline development have discouraged successful breeding activity in the planning area in recent years.

Great blue herons are fairly common throughout the planning area, primarily associated with wetland areas, roadside ditches and open areas, such as the Sudden Valley Golf Course. No known nesting colonies exist within the planning area, but complete inventories have not been conducted.

Ospreys have been recorded nesting near Lake Whatcom since the mid-1960s, with the most recent nest site being identified along the Lake Louise road, near Sudden Valley.

Only a few breeding territories of northern goshawks have been recorded for the northwest portion of Washington. An adult goshawk was observed with juveniles in 1979, on private property in the central portion of the planning area. It is assumed that nesting took place somewhere in the vicinity of this sighting. Complete inventories for goshawks are extremely difficult and time-consuming to conduct.

Pileated woodpeckers and Vaux's swifts are found throughout the planning area (the latter found during the breeding season). Olive-sided flycatchers are not common, but do occur in suitable habitat in the planning area (typically near older stands, with nearby openings). Known nesting by purple martins was documented in 1975 and 1977, in bird boxes located just southeast of Bloedel-Donovan Park.

A nursery colony of Townsend's big-eared bats was located in 1986 in an abandoned building located in the southern portion of the planning area. Because these bats also use caves, old mines, and bridges for day and night roosts, as well as maternity colonies, it is also possible that the Blue Canyon Mine (and any other deserted mines in the planning area) provide habitat for this species.

The Yuma Myotis is a small bat that is fairly common and likely to occur within the planning area, although no individuals have been specifically identified there. No detections have been made of the Keen's Myotis, either, but it is a species that is rarely encountered in the wild. It is included in the assessment because the planning area falls within its geographical range, and it is a State Candidate for listing.

Tailed frogs have been documented as breeding in 1995 along the lower lengths of Austin Creek. This species is strongly associated with permanent cold, clear, fast-flowing headwater streams, and is particularly susceptible to land management activities that increase runoff and siltation (i.e., result in increased sediment input). The western toad is fairly common and likely to occur in the planning area. It is a Federal Species of Concern and a State Candidate species due to the apparent decline of some localized populations of the subspecies boreal toad (*Bufo boreas boreas*).

When relevant, potential impacts of the alternatives to the above-listed species of interest are discussed, as well as possible mitigation measures on a species-specific basis. Some wildlife species are addressed as they relate to species groups (e.g., neotropical migratory birds). However, the overriding analysis of impacts to habitat availability focuses on guilds of species that share breeding and feeding habitat preferences (i.e., "life forms"). The "life form" concept was originally derived from Thomas (1979) and Brown (1985), and was further refined by Lundquist and Hicks (1995) in the development of a multi-species approach for a habitat conservation plan for the Plum Creek Timber Company. Only life forms that are relevant to the Lake Whatcom landscape were selected for analysis. The life forms include:

Life form 8 – Birds that breed in shrubs, and feed in trees, shrubs, or in the air. These species tend to concentrate in shrub communities in young to middle-aged forest structural types. However, they are not as dependent on riparian and wetland areas as some species.

Life form 10 – Birds that breed in conifers, feed in trees, shrubs, or the air.

Life form 11 – Birds that breed in conifers and deciduous trees while feeding in trees, shrubs, on the ground, or in the air. Oriented toward structural stages with larger trees but can use younger forests if residual trees are present.

Life form 13 – Primary cavity-excavator birds that nest in snags and defective trees.

Life form 14 – Species (birds, bats, flying squirrel, raccoon, and mink) that use cavities or hollows created by defects or actions of other species. Tend to breed primarily in more developed structural stages, but use a somewhat wider variety of special habitats or features than life form 13. Primary habitat is in mature and old-growth forests.

Species that are likely to occur within the planning area are listed below for each life form. Other wildlife species that are likely to occur within the planning area (but are not addressed specifically) are listed in the wildlife assessment in Appendix D.

Table 9: Wildlife species, by life form, whose habitat needs were used for assessing probable impacts under each of the five alternatives.

Life form 8: bushtit (*Psaltriparus minimus*) yellow warbler (*Dendroica petechia*) MacGillivary's warbler *Oporornis tolmiei*) American goldfinch (*Carduelis tristis*) **Life form 10:** olive-sided flycatcher (*Contopus borealis*) golden-crowned kinglet (*Regulus satrapa*) ruby-crowned kinglet (*Regulus calendula*) yellow-rumped warbler (*Dendroica coronata*) black-throated gray warbler (*Dendroica nigrescens*) Townsend's warbler (*Dendroica townsendii*) western tanager (*Piranga ludoviciana*) red crossbill (*Loxia curvirostra*) Douglas' squirrel (*Tamiasciurus douglasii*) **Life form 11:** sharp-shinned hawk (*Accipiter striatus*) Cooper's hawk (*Accipiter cooperii*) northern goshawk (*Accipiter gentilis*) band-tailed pigeon (*Columba fasciata*) mourning dove (*Senaida macroura*) long-eared owl (*Asio otus*) rufous hummingbird (*Selasphorus rufus*) western wood-peewee (*Contopus sordidulus*) Pacific slope flycatcher (*Empidonax difficilis*) gray jay (*Perisoreus Canadensis*) Stellar's jay (*Cyanocitta stelleri*) American crow (*Corvus brachyrhynchos*) common raven (*Corvus corax*) American robin (*Turdus migratorius*) varied thrush (*Ixoreus naevitus*) solitary vireo (*Vireo solitarius*) warbling vireo (*Vireo gilvus*) chipping sparrow (*Spizella passerina*) purple finch (*Carpodacus purpureus*) pine siskin (*Carduelis pinus*) evening grosbeak (*Coccothraustes vespertinus*) hoary bat (*Lasiurus cinereus*)	**Life form 13:** red-breasted sapsucker (*Sphrapicus rubber*) downy woodpecker (*Picoides pubescens*) hairy woodpecker (*Picoides villosus*) northern flicker (*Colaptes auratus*) pileated woodpecker (*Dryocopus pileatus*) red-breasted nuthatch (*Sitta canadensis*) **Life form 14:** wood duck (*Aix sponsa*) common goldeneye (*Bucephala clagula*) bufflehead (*Bucephala albeola*) hooded merganser (*Lophodytes cucullatus*) common merganser (*Mergus merganser*) common barn owl (*Tyto alba*) western screech owl (*Otis kennicottii*) northern pygmy owl (*Glaucidium gnoma*) barred owl (*Strix varia*) northern saw-whet owl (*Aegolius acadicus*) Vaux's swift (*Chaetura vauxi*) violet-green swallow (*Tachycineta thalassina*) black-capped chickadee (*Parus atricapillus*) chestnut-backed chickadee (*Parus rufescens*) brown creeper (*Certhia Americana*) Bewick's wren (*Thryomanes bewickii*) winter wren (*Troglodytes troglodytes*) northern flying squirrel (*Glaucomys sabrinus*) big brown bat (*Eptesicus fuscus*) California myotis (*Myotis californicus*) Keen's myotis (*Myotis keenii*) little brown myotis (*Myotis lucifugus*) long-legged myotis (*Myotis volans*) Yuma myotis (*Myotis yumanensis*) American kestrel (*Falco sparverius*) raccoon (*Procyon lotor*) mink (*Mustela vison*)

Forest Habitats: Quality and Quantity

State lands within the planning area are currently dominated by mid-seral forest stands in the pole/closed seral stages (see Map J-1 – Age Class from FRIS Data). *[See "Forest Vegetation" for a description of the forest age distribution, species and structural character.]*

Vegetative conditions and their spatial distribution on the landscape likely provide suitable habitat for a variety of wildlife species (see Appendix D) within the planning area. Due to the scarcity of both early- and late-seral stages, overall wildlife diversity is probably limited, as these seral stages generally support a greater variety of wildlife species than do the mid-seral stages, which dominate the landscape at this time.

Most noteworthy regarding the size and spatial arrangement of forest stands within the planning area is the existence of contiguous “mature” forest on state lands in several locations (as determined by orthophoto interpretation). This type of forest is generally at least 60 years old. In the middle-western portion of the planning area (on Lookout Mountain), there are roughly 900 acres of forest stands that are broken up by very few roads. There is a smaller amount of contiguous, unroaded forest in the southwestern portion, as well. There is also a considerable amount of mature forest just to the southeast of the planning area, primarily on Anderson Mountain, although this area contains more roads. The largest block of contiguous forest habitat within the planning area is located in the eastern (mid) and northeastern portion. There are relatively few roads in this area, although part of this block is broken up by a powerline right-of-way.

A significant feature of this landscape is its isolation from other forested landscapes. There is little to no connectivity between the forested stands within the planning area and others adjacent to or beyond it, due to the level of human development surrounding most of it. Beyond the planning area boundaries, there is the city of Bellingham to the northwest, I-5 to the west, and Highway 9 to the southeast and east. Between the planning area and these roadways, there is considerable rural development and/or private forestlands that are predominately in early seral stages (0-20 years old). To the east of the planning area is the Samish River drainage, and farther to the northeast is the Nooksack River, but these features are separated from the planning area by developed lands, particularly in the Samish Valley.

Areas that have been developed *within* the planning area are primarily concentrated in the northwestern, middle-western, and south/southwestern portions. These include the Sudden Valley housing development, as well as areas north of Lake Louise and in the vicinity of South Bay and Cain Lake.

There appear to be few unique or special habitats (such as wetlands, cliffs, talus, caves, or balds) within the planning area, according to orthophoto interpretation and local knowledge. More complete information on the locations of such habitats can only be acquired through field inspections, which is beyond the scope of this assessment. Such habitats would be protected under all of the proposed alternatives, based on the HCP, and would be identified during project-level reconnaissance.

Scoping comments were received regarding a bigleaf maple stand in the landscape. This high-site stand of older trees, with an understory of western redcedar and Douglas-fir, has a unique stand composition and open cathedral structure. It likely provides moderate to high wildlife value. There is no data, however, on whether or not this stand provides specific habitat values not available in adjacent stands.

<u>Fish</u>

Fish Species Found in Lake Whatcom

Since the early 1900s, at least 15 native and non-native fish species have been documented in Lake Whatcom (Dominguez, 1997). These fishes are:

Native:
- cutthroat trout (*Oncorhynchus clarki clarki*)
- kokanee (*Oncorhynchus nerka*) – non-anadromous sockeye salmon
- peamouth (*Mylocheilus caurinus*)
- cottid (*Cottus* spp.)

Non-native:
- brook trout (*Salvelinus fontinalis*)
- lake trout (*Salvelinus namaycush*)
- yellow perch (*Perca favescens*)
- brown bullhead (*Ictalurus nebulosus*)
- largemouth bass (*Micropterus salmoides*)
- smallmouth bass (*Micropterus dolomieui*)
- other trout sub-species (Beardslee, Yellowstone black-spotted cutthroat (Tokul Creek, Kamloops)

For the purpose of this analysis the habitat needs of the native cutthroat and kokanee will mainly be addressed, and it will be assumed that the habitat needs of the other native and non-native fishes are met. The term "salmonids" is used to refer to the taxonomic family salmonidae, of which both the cutthroat and kokanee are members.

*Cutthroat***:** Cutthroat trout are native to the Lake Whatcom drainage. Due to an impassable waterfall, cutthroat of the Lake Whatcom drainage are all of the "resident" non-anadromous variety. It is believed that resident cutthroat evolved from post-glacially isolated sea-run cutthroat populations.

Lake Whatcom cutthroat spawning generally occurs from December to mid-June. Resident cutthroat have been found to make short movements to spawning areas (Liknes and Graham 1988; Varley and Gresswell 1988), and are known to spawn within a variable range of gravel particle sizes (Hunter 1973; Thurow and King 1994; Quinn and associates, unpublished data). Because these fish are relatively small, spawning generally occurs in small sized gravel particles (<1 inch diameter gravel and sand). Factors such as fish body size, water depth, gravel availability and water velocities are site-specific determinants for the preferred substrate sizes.

Although no observations of cutthroat spawning were made during watershed analysis (Dominguez 1997), spawning is known to occur in several Lake Whatcom tributaries, including: Carpenter Creek, Smith Creek, Anderson Creek, Brannian Creek, Beaver Creek and the Squalicum Interbasin.

Cutthroat may spend significant portions or their entire lives in a very small stream area, or even in a particular pool (Miller 1954; 1957; Lestelle 1978; Heggenes et al. 1991a, 1991b). Cutthroat use logjams, upturned roots, and accumulations of large woody debris (LWD) as winter habitat (Bustard 1973; Bustard and Narver 1975b) They also are very dependent on channel stability, low flow refuge, and lateral habitat and cover for rearing (Moore and Gregory 1988a; Lestelle 1978). Resident fish may not be able to maintain positions in refuge areas during excessive bedload and debris movements (Dominguez, Watershed Analysis).

Water Types 3, 4 and 5 make up 97 percent of Lake Whatcom tributary lengths, and several Type 3 streams in Lake Whatcom have physical characteristics similar to Type 4s and 5s of larger river systems. Several lake tributary segments are used for only short reaches on the downstream ends, sometimes for only 100-200 meters. The channels upstream of these sites are very important in maintaining production of these short reaches and are given recognition for their importance in maintaining quality habitat (Dominguez, Watershed Analysis).

Cutthroat are common throughout the Lake Whatcom planning area; however, their distribution can be limited by extremely steep gradients and high waterfalls. Some populations even exist in isolation above waterfalls (Dominguez 1997, Appendix F (F-7)). According to Dominguez (1997) native cutthroat spawn and/or rear in all Type 3 streams in the Lake Whatcom drainage.

Austin and Beaver creeks – and to a lesser degree Carpenter, Olson and Smith creeks – are the most important cutthroat producing tributaries of the Lake Whatcom drainage. Minimal areas of spawnable-sized gravel exist, and siltation of those areas is a common occurrence among most of the tributaries. The armoring effect of many gravel and cobble dominated reaches can be misleading in terms of amount of fines present. Some segments used for spawning in Olson, Carpenter, Beaver and Austin creeks are so heavily compacted that the gravel is only moderately vulnerable to increased fine sediment input. Most fine sediment is transported through these reaches because the gravels and cobble are already filled with fines (Dominguez, Watershed Analysis).

Cutthroat redds, however, are susceptible to intrusion of fines in these areas after redd construction has occurred. The one mitigating factor for cutthroat trout is their extensive distribution throughout the watershed. The Chuckanut Sandstone geology contributes to a relatively high natural level of fines in some areas. These areas are also subject to scour, and spawning resident trout populations may be affected most by the lack of gravel retention in headwater streams. Many streams lack the stepped profiles vital to regulating gravel transport and retaining spawning gravel (Heede 1972; Marston 1982; Channel Module Report for this WAU) (Dominguez, Watershed Analysis).

Summer rearing habitat of cutthroat is affected by subsurface flows. These flows occur in Carpenter Creek, several downstream portions of Blue Canyon tributaries, Fir Creek, Brannian Creek, Beaver Creek, Squalicum Interbasin and throughout several small tributaries draining directly into Lake Whatcom. Subsurface flows may be the natural condition of these streams, because the basin exhibits generally steep terrain which limits water impoundment capability. Excessive sedimentation in many streams contributes to the low flows and subsurface flows. Beaver dams in Brannian Creek and Squalicum Interbasin contribute the positive benefits of prolonged surface flows through the summer, and buffering of intense streamflow periods in the winter (Dominguez, Watershed Analysis).

During winter, cutthroat are dependent on the quality and quantity of rearing habitat. Buffered by their capacity to seek out rearing and spawning habitat in small tributaries (Hartman and Scrivener 1990), cutthroat populations are generally resilient to the short-term impacts of main-channel habitat degradation. Lake Whatcom tributaries provide very limited refuge during channel disturbances. The long-term trend for cutthroat when winter habitat is reduced may be a reduction in stream productivity or a reduction in presence of older trout year-classes (Hall et al. 1987; Cederholm, unpublished data) (Dominguez, Watershed Analysis).

Kokanee: Kokanee are a native salmonid fish species in Lake Whatcom. It is believed that the kokanee of Lake Whatcom evolved from anadromous sockeye populations that have been historically deprived of ocean access due to Whatcom Falls (Ricker 1940; Groot and Margolis 1991). Like the anadromous form of sockeye, kokanee require a lake in their life-history, and generally, the lake is used for juvenile rearing and growth and the tributaries for spawning (Dominguez 1997, Appendix F (F-5)).

Information on natural production of kokanee in Lake Whatcom is scarce, other than a few periodic spawner surveys in the mid-1970s and other anecdotal information. Significant spawning kokanee populations have been observed in Brannian, Olson, Fir and Anderson creeks, and to a lesser extent, Carpenter, Smith and the lower portions of several unnamed creeks. Shoreline spawning can occur near South Bay Hatchery, especially after a flood event displaces the kokanee that have migrated into the lower portion of Brannian Creek (Dominguez 1997, Appendix F (F-6)).

Lake Whatcom kokanee spawn from late August through January (historically through February (Looff 1994)). The majority of spawning occurs from late October through early December (Looff 1994). Most Lake Whatcom kokanee spawn in their third year (2+) although there may be some in their second and fourth (1+ and 3+) years (Dominguez, Watershed Analysis).

Kokanee prefer water depths of 1 foot or less for spawning and velocities ranging from 0.4–2.0 feet/sec. (Hunter 1973). Kokanee maintain a sensitive response to environmental conditions during their spawning stage (DeLisle 1962; Lorz and Northcote 1965; Smith 1973). Kokanee, like their anadromous counterpart, are generally mass-spawners. There are several advantages that a mass-spawning species has, such as genetic resilience/diversity from mass egg depositions, natural selection process from redd superimposition, easy availability of mates, thorough gravel cleaning, long-term maintenance of gravel quality, maximization of fry output from spawning areas, safety from predators, and creation of additional spawning habitat by moving sediment into pool areas and cutting into gravel bars (Dominguez, Watershed Analysis).

Upon emergence from the intragravel environment in late January through March, kokanee fry generally migrate to Lake Whatcom within a few days. In the juvenile stage they inhabit shoreline areas and feed largely on plankton, supplementing their diets with copepods, cladocera and insects (Dominguez, Watershed Analysis).

Kokanee generally stay in schools during adult life and may migrate around the lake about 100+ yards off shore. Lake Whatcom kokanee are generally smaller than average when compared to other kokanee in the Pacific Northwest. Lake Whatcom's nutrients (mainly phosphorus) may be absorbed and precipitated by fine particulates (URS 1985). Rieman and Myers' (1992) data suggest that kokanee growth is strongly influenced by lake productivity (Dominguez, Watershed Analysis).

Most of the observed segments of natural kokanee spawning habitat in Smith Creek, Fir Creek and South Bay Interbasin either exhibited excessive fines or a high level of compaction. Small-bodied salmon generally lack the ability to effectively mobilize severely compacted gravels. Biologists generally agree that when eggs are laid in shallow redds in unstable streams, their likelihood of scour increases during ensuing storm events. Burner (1951) suggests that the degree of gravel compaction affects the ease of digging, and salmon may avoid highly compacted areas altogether (Dominguez, Watershed Analysis).

Kokanee have been observed spawning in shoreline areas near Brannian Creek when access to tributaries has been hindered by low flows (Cole pers. Com.). Brannian and Fir interbasins possess shoreline characteristics conducive to kokanee spawning (Hiss 1983; Groot and Margolis 1991). Upwelling and wave action can create suitable incubation conditions regardless of the percent fine composition; however, mass accumulations of gravel and fines in the alluvial areas during winter storm events may entomb the egg pockets and suffocate the eggs or drastically reduce emergent fry success (Dominguez, Watershed Analysis).

Migration Routes and Obstacles

Adult cutthroat and kokanee must reach spawning grounds at the proper time and with sufficient energy reserves to complete their life cycles. Stream discharges, water temperatures and other water quality parameters must be suitable during at least a portion of the migration season (Bjornn and Reiser 1991). Waterfalls, road culverts**,** debris jams and excessive water velocities may impede migrating fish. It is important to note that waterfalls that are insurmountable at one time of the year may be passed at other times when flows have changed. Adult and juvenile fish migrating upstream must have stream flows that provide suitable water velocities and depths for successful upstream passage (Bjornn and Reiser 1991). Because kokanee and cutthroat are small-bodied salmonids they have limited jumping and swimming ability (Washington Department of Natural Resources 2001).

Culvert passage problems affecting cutthroat habitat exist in the Lake Whatcom basin in North Shore, Blue Canyon, South Bay and Geneva interbasins. Stream gradient generally increases rapidly beyond these culverts (Dominguez, Watershed Analysis).

Riprap from the old railroad crossing may be inhibiting kokanee spawner migration in Anderson Creek. However, because there is potential for passage, the barrier may be described as a difficult passage (Dominguez, Watershed Analysis).

Kokanee migration problems associated with low stream flows are exacerbated by alluvial aggradation on several larger streams (Carpenter, Olson, Smith, and Brannian) and some tributaries (segments of Blue Canyon and South Bay interbasins). Observations at the Brannian Creek Hatchery indicate that kokanee will leave staging areas at the mouth of Brannian Creek and go to other streams to spawn if flows are not adequate (Harvard, pers. com.). Attempts to swim up rivulets with no cover are hampered by avian predator encounters and dead end shallow pools with no cover (Dominguez, Watershed Analysis).

Riprap and artificial entrenchment: Numerous segments within the watershed have been diked or leveed. These artificial constraints on channel pattern have greatly altered the natural sediment transport and disturbance processes, which originally formed these channels. Entrenchment of lower Austin Creek, for example, has resulted in a channel with a much coarser bed than expected due to an increase in sediment transport capacity created by the constructed banks and removal of large woody debris. These constraints have also eliminated the potential for formation of side-channel habitat and for the recruitment of wood via bank erosion or channel shifting.

Fish Habitats: Quality and Quantity

For additional information on the specific fish habitats of Lake Whatcom and its tributaries, beyond what is provided below, see: The Final Report on Forest Practices and Their Effect on Water Resources in the Lake Whatcom Watershed: A Review of Existing Information, prepared by Jeff Grizzel, Forest Hydrologist, Washington Department of Natural Resources. For trends in stream channel disturbance in the Lake Whatcom drainage, see descriptions in the Lake Whatcom Watershed Analysis (December 16, 1997).

All freshwater life stages of salmonids require several major habitat factors, including: access to habitats; moderate stream flows; cool, clean well-oxygenated water; low levels of silt within the spawning gravels; low suspended-sediment load; adequate food supply; and relatively stable stream channels formed by frequent accumulations of large woody debris (Dominguez, Watershed Analysis).

The riparian ecosystem is where aquatic and terrestrial habitats interact (Cederholm 1994). From shoreline to uplands, there exists a continuum of physical and biological processes that contribute to productive salmonid habitats. The riparian ecosystem can be effectively modeled as three unique zones: the aquatic zone, riparian zone and a zone of direct influence (Naiman et al. 1992). The aquatic zone is the location of aquatic environments, including the complete channel migration zone, where water may be present during any time of the year. This zone is often referred to as the 100-year flood plain. Adjacent to the aquatic zone is the riparian zone, a narrow band of moist soils and distinctive wetland vegetation. Beyond the riparian zone lie uplands. The spatial extent of upland influences on aquatic ecosystems delineates the direct influence zone. The health of the aquatic zone is positively influenced by the terrestrial areas within the riparian and upland direct influence zones (Cederholm 1994). Salmonids inhabit the aquatic zone, but, in effect, their habitat encompasses the entire watershed.

Each salmonid life stage has slightly different critical habitat requirements, and a lack of suitable habitat for a single life stage could affect the viability of an entire stock. Eggs incubating in a redd require a high concentration of dissolved oxygen, which is a function of several environmental variables: water temperature, biological oxygen demand, stream flow, and sediment load (Bjornn and Reiser 1991). High biological oxygen demand, caused by microbial decomposition of organic materials, can decrease the amount of fresh oxygenated water moving through the redd (Bjornn and Reiser 1991). Fine sediments settle into the spaces between gravel and can impede the flow of water to the eggs (Everest et al. 1987). Excessively high streamflows and associated streambed scour can destroy redds and the incubating eggs and alevins that they contain (Schuett-Hames 1996).

Alevins reside in the redd, where they need clean, cool, well-oxygenated water for incubation. Heavy sediment loads can negatively affect alevins in an additional way, by blocking the emergence of fry and entombing them within the gravel environment (Everest et al. 1987).

Fry and parr depend on good water quality, abundant food supply, cover, and living space (Bjornn and Reiser 1991). Water temperatures affect the rate of growth and development, as all cold-water fish cease growth at temperatures above 68.5 degrees F (Reiser and Bjornn 1979). The preferred temperature range of all salmonids is between 50 and 57 degrees F; and the upper lethal temperature limit lies between 73.4 and 78.4 degrees F (Reiser and Bjornn 1979).

High loads of suspended sediment may abrade and clog salmonid gills (Noggle 1978; Reiser and Bjornn 1979). Too much fine sediment (material that is sand sized and smaller) deposited on the streambed may negatively affect juveniles by destroying their food supply (Reiser and Bjornn 1979).

Stream productivity and riparian vegetation are two factors that affect the density of insects and other aquatic macroinvertebrates, the principal prey of juvenile salmonids. The amount of detritus present in a stream is an important variable affecting stream productivity (Bjornn and Reiser 1991). High stream productivity leads to high densities of herbivorous aquatic insects. Terrestrial insects enter streams by falling or being blown off riparian vegetation; this input has been found to be an important component of the prey base of juvenile salmonids (Reiser and Bjornn 1979).

Stream-dwelling salmonids benefit from habitat complexity. Stream habitat complexity relates to a high diversity in the size, location and variety of physical, hydrological and biological elements, including: a variety of gravel sizes, pools of various depths, riffles, eddies, side channels, undercut embankments, boulders, aquatic vegetation, amount of cover in the form of large woody debris are among the elements that contribute to stream complexity.

Water Temperature: Water temperature is principally a function of vegetative cover. Over-stream vegetation moderates energy flow into and out of aquatic ecosystems (Chamberlin et al. 1991). Removing riparian vegetation and the shade it provides increases summer water temperatures. Lower winter water temperatures may also occur because removing riparian vegetation allows heat to escape (Chamberlin et al. 1991).

The degree to which water temperature is affected by riparian vegetation is a function of stream size (Chamberlin et al. 1991). For example, the temperature of shallow water bodies responds more quickly to changes in air temperature, and the temperature of small streams is more sensitive to changes in riparian vegetation because the forest canopy covers a higher proportion of the stream's surface (Chamberlin et al. 1991).

Sediment Load: Riparian buffers can intercept sediments flowing from uphill disturbances. Sediments are delivered naturally from uplands to riparian ecosystems primarily through landslides and road surface runoff (Reid 1981; Reid and Dunne**)**. Landslide events rapidly add large quantities of material to the stream network. In undisturbed watersheds, the concentration of sediments increases substantially during storms, and much of this increase is the direct result of soil mass-wasting (landslides) (Swanston 1991).

Roads in upland areas can have significant detrimental impacts on salmonid habitat. In few locations can roads be built that have no negative effects on streams (Furniss et al. 1991). In the Pacific Northwest, logging roads appear to contribute more to landslides than clearcutting, although this association varies substantially with location (Sidle et al. 1985), and seems to be highly dependent on watershed hydrology and geomorphology (Duncan and Ward 1985). Cederholm et al. (1981) reported a significant positive correlation between fine sediment in spawning gravels and the percentage of basin area covered by logging roads.

Fine Sediment: Sources of fine sediment are numerous within the basin, with the greatest transport occurring in Austin and Smith subbasins. Hydrologic Simulation Program Fortran (HSPF) modeling results based on 11 streams feeding Lake Whatcom suggest that Smith and Austin creeks, while accounting for only 37 percent of total flow, accounted for 93 percent of the suspended sediment load (suspended solids), most of which was associated with a few large storm events (Walker et al. 1992). Common features likely responsible for the high loads are the occurrence of landslide-prone slopes directly adjacent to streams, the lack of storage capacity due to continuously steep gradients and tight confinement, and extensive scour following the 1983 event which left numerous exposed surfaces available for chronic surface erosion.

A sediment budget for Smith Creek (Gacek and Assoc. 1990) suggests that landslides are the largest source of sediment and that this material is largely fine textured (70 percent is <11.2 mm). Considering the extremely large quantities delivered to the channels during the 1983 event and the current scarcity in most segments, fine sediment must be largely transported out of these subbasins. Additionally, quick attrition of Chuckanut sandstone and siltstone to fines within the mainstem of Austin Creek has also been observed (Mary Raines, Personal comm.). Over a distance of 450 m downstream, mean particle size of fine-grained siltstone, sandstone and mudstone decreased by 50 percent and the number of fine grained rocks that broke easily by hand decreased 48 percent. While far from conclusive, these findings suggest that inputs of gravels and fines into most reaches draining the Chuckanut have quick breakdown rates and are readily transported into low gradient reaches (near the lake) or entirely out of the subbasin.

In contrast to Smith and Austin, Olsen Creek seems to have chronic fine sediment inputs. While a paucity of deep pools prevented the accumulation of deep deposits, fine sediment was observed around most flow obstructions as sand stringers and in the interstices of gravel and cobble. The scour or burial of many channel roughness elements (primarily LWD) needed to direct/focus stream energy following the 1983 event has resulted in limited sorting of channel sediments and a more random distribution of fine sediment. The absence of obstructions and high availability of sediment is also characteristic of Carpenter, Fir and Anderson creeks. It should be noted that very large quantities of fine sediment are also being imported into Lake Whatcom via Anderson Creek and the Middle Fork of the Nooksack water diversion.

Nutrient Load: The amount of small organic debris accumulations (detritus) affects stream productivity (Bjornn and Reiser 1991). High stream productivity is characterized by high densities of herbivorous aquatic macroinvertebrates. In forested headwater streams, riparian vegetation is the primary source of detritus (Gregory et al. 1987; Richardson 1992). Removal of vegetation along these streams will lessen this input and can negatively affect the long-term productivity of downstream areas.

Stand age and canopy cover significantly influence detrital input to a stream system. Old-growth forests contribute approximately five times more detritus to streams as clearcut forests (Bilby and Bisson 1992). Richardson (1992) found that old-growth forests contributed approximately double the detritus as either 30 or 60-year-old forests. However, even though streamside timber harvest reduces detrital input, the resulting reduction in forest canopy can lead to increased light levels and consequent algal production in the aquatic zone, which in turn produces a short-term pulse of autotrophic productivity (Bilby and Bisson 1992). Streamside harvest is allowed along Type 5 waters under the HCP.

Erman et al. (1977) found that the composition of invertebrate communities in streams with riparian buffers wider than 100 feet was indistinguishable from those of unlogged streams. From this result, FEMAT (1993) inferred that riparian buffers at least 100 feet wide delivered sufficient small organic material to maintain a diverse aquatic community.

Large Woody Debris: The input of large woody debris (woody material at least 10 cm in diameter and 2 m long) from the riparian corridor is the most important link between terrestrial and aquatic ecosystems, acting on stream flows to create essential elements of salmonid habitat – deep pools, riffles, side channels, and undercut embankments (Swanston 1991; Maser et al. 1988). Large woody debris causes lateral migration of the stream channel, creating backwaters along stream margins and increasing variations in depth (Maser et al. 1988). Large woody debris serves as cover for fish from predators and competitors (Bjornn and Reiser 1991) and moderates the energy of stream flows, thereby decreasing streambed scour and bank erosion. Log jams perform at least four main functions:

(1) They store fine sediments in Type 4 and 5 streams that would adversely affect downstream spawning areas and invertebrate populations.
(2) They retard the flow of nutrients down the channel, thus increasing stream productivity.
(3) They retain gravel of various sizes essential to salmon spawning (Bisson et al. 1987).
(4) They create turbulence that scours deep pools, important to rearing older age-class trout and salmon.

During floods, LWD in the riparian zone is important for the maintenance and development of riparian soils. Large woody debris performs at least three functions during floods:

(1) It moderates the energy of stream flows.
(2) It stabilizes soils, and
(3) It traps suspended sediments and organic nutrients.

Saturated soils of riparian zones may impede the regeneration of conifer species. Large woody debris can enhance conifer regeneration by acting as nurse trees for seedlings.

Through stream bank erosion, windthrow, tree mortality, and beaver activity (Bisson et al. 1987), the riparian zone supplies nearly all the LWD. The probability that a fallen tree will enter a stream is a function of distance from the channel and tree height (Van Sickle and Gregory 1990).

Measurements of LWD input to streams in western Washington and Oregon indicate that in old-growth conifer forests riparian buffers 120 feet wide would be 90 percent effective in delivering LWD to aquatic ecosystems. In terms of tree height, McDade et al. (1990) show that 90 percent of the potential LWD lies within a zone whose width is approximately 60 percent of the height of the average tree in the riparian ecosystem.

Instream stability and longevity of LWD are assumed to be important for its ecosystem function (Bisson et al. 1987). Stability is a function of size, with debris length relative to stream width having the greatest effect (Bisson et al. 1987). Instream longevity of LWD is a function of both size and species of wood; larger pieces are more resistant to breakage, and conifers are more resistant to fragmentation and decomposition than red alder (Bisson et al. 1987), a hardwood often associated with riparian areas.

Large woody debris surveys performed by the fish habitat and stream channel analysts indicate a widespread lack of functioning LWD in most segments within the Lake Whatcom watershed. There are several factors likely contributing to the current condition:

- The 1983 storm resulted in the flushing of both sediment and LWD from many channels and local deposits/accumulations were generally removed to promote more efficient water conveyance.
- Current riparian stands are dominated largely by 30- to 40-foot-tall alder. Potential recruitment of large conifers in the near term is extremely low.
- Removal and/or conversion of riparian vegetation associated with residential developments, road construction, agriculture, a golf course and debris torrent scour of adjacent bedrock walls has jeopardized both near and long-term recruitment of LWD (particularly large conifers).
- Periodic removal of LWD along mainstem reaches of Smith Creek has occurred since 1983 in an attempt to reduce potential hazards to downstream residences and to reduce risk of lawsuit to upslope landowners. Though the efficacy of this activity has not been evaluated, an outcome of a 1983 out-of-court settlement was an agreement to monitor (not remove) LWD within Smith Creek.

LWD Recruitment Processes: Recruitment mechanisms for channels consist largely of mass wasting events and wind throw on steep adjacent valley walls. The extreme steepness of many of these walls (>90 percent) likely facilitates transport of windthrown trees into the channel from distances greater than their tree height. Infrequent transport of LWD through steep gradient reaches may also be important for fan channels. Where gradients are less and catastrophic disturbance is rare, bank failure and channel migration are important. These processes are frequently restricted by riprap and constructed levees/dikes.

Wind Buffers: The stability and longevity of riparian buffers has been an issue of concern (Steinblums et al. 1984; FEMAT 1993). Windthrow may compromise the intended function of the riparian management zone. A single windstorm could raze entire sections of the riparian buffer, or successive high wind events may, over longer periods, slowly degrade the integrity of the riparian ecosystem. Windthrow is vital to riparian ecosystems in natural forests – a significant proportion of all instream large woody debris (Murphy and Koski 1989; McDade et al. 1990) is blowdown – but the aerodynamics of the abrupt forest edges, which commonly occur between riparian buffers and clearcuts, cause more frequent catastrophic windthrow events and accelerated rates of blowdown. The purpose of the wind buffer under DNR's HCP is to increase the stability and longevity of the riparian buffer, i.e., to maintain its ecological integrity.

Processes in Steep Gradient Chuckanut Channels: Many channels within the watershed, particularly those draining Olsen, Smith and Austin creeks, are presently recovering from widespread scour associated with numerous debris torrent/dambreak flood events in January 1983. With the exception of Quiet Creek, the bed and banks of most steep gradient segments in Smith Subbasin are frequently scoured to bedrock. With the exception of isolated debris flow terraces, storage of coarse and fine sediment is minimal. The sediment input to Smith Creek is predominately fine textured; 45 percent of the sediment (by weight) is less than 2.0 mm and 70 percent is less than 11.2 mm (Gacek Assoc. 1990). Lack of storage within Smith Creek is reinforced by the observation that extensive inputs of sediment from the 1983 event are currently not found in the channel.

Mass wasting is perhaps the dominant channel-forming process within these subbasins. The presence of large alluvial fans with numerous abandoned channels radiating from their apices highlights the dynamic nature of these channels and their inherent tendency to rapidly change course as a result of pulses of sediment or woody debris. Structures that attempt to confine these channels, most notably the dikes along lower Smith Creek, limit channel shifting/sinuosity and thereby increase the transport capacity, resulting in more immediate transport of sediment to the lake. Historically, the Smith Creek fan probably had numerous side channels and LWD-formed steps that have been simplified into single thread plane-bed reaches. While the dikes on Smith Creek limit the degree of deposition near the fan apex, the distance between dikes widens near the lakeshore, facilitating aggradation of fine and coarse sediment. Efficient conveyance of sediment and water during catastrophic events and containment within the dike will likely diminish with continued aggradation upstream. In addition, WCPB (1992) has observed that the Smith Creek dikes are composed of finer material than that currently transported as bedload and that their foundations are not keyed below the level of maximum flood scour, indicating that dike walls are susceptible to extensive erosion during peak flow events.

One important trigger mechanism of dam break flood events is extensive logging slash delivered either directly or via entrainment in a landslide, into tightly confined first and second order channels (with gradients between 10-30 percent). Coho and Burgess (1994) and Weyerhaeuser Co. (1996) found that thick layers of logging slash are commonly associated with the initiation points, indicating the importance of slash in creating a backwater (upstream) head and subsequent downstream surge (dam break flood).

A policy of active wood removal within Smith Creek has resulted in reduced storage capacity of coarse and fine sediment. Reconnaissance up Quiet Creek found LWD to be locally important in step formation and bank protection. While bedrock and boulders are the dominant pool forming elements in these subbasins, LWD would likely promote sediment storage and step formation during the roughly 60 to 70 years between channel scouring events. Scour of valley walls to bedrock has greatly limited the near-term establishment of riparian vegetation, thus increasing the importance of recruiting large conifers growing within the inner gorges but above the zone of channel scour.

Where valley widths increase (moderate confinement), generally associated with outcrops of less resistant siltstone and shale, debris flow deposits on channel margins occur. As these unconsolidated deposits are easily eroded during peak flow events, LWD may provide needed local protection of sparsely vegetated terrace deposits. Along many reaches where alluvial terraces occur, namely Olsen, lower Smith Creek, Carpenter and Fir creeks, LWD is deposited against the valley wall or on the terrace. Subsequent channel incision into terrace deposits has resulted in continued isolation of LWD during all but extreme flows (e.g., 10 year recurrence interval flows). Significant incision into unconsolidated glacial outwash was also observed in North Shore Interbasin resulting in limited current hydraulic effectiveness and low future recruitment potential of LWD.

ENERGY AND NATURAL RESOURCES (4.1.1.5)

Energy Resources

Energy resources potentially present within the landscape planning area are mainly coal and gas. It should be noted that mineral rights, including oil, gas, coal and metallic minerals are not uniformly held by the state on all state-managed parcels within the planning area. In some trust parcels the mineral rights are held by third parties; in some cases, third parties hold 50 percent of the mineral rights. This limits DNR's ability to manage the mineral activity within these tracts.

Coal:

There currently are no coal leases of State trust lands or active coal mines within the landscape planning area. However, coal lease option contracts on state lands were active in the past. There are also no mineral lands designated under the growth management act (GMA) within the landscape planning area. Any mineral development including coal, sand, gravel or metallic minerals would require a conditional use permit and a rezone with the county before any mining activity could proceed.

Much of the area underlying the landscape planning area consists of Late Cretaceous to early Tertiary Eocene age Chuckanut formation. This formation is the host for coal seams that were exploited in a number of historic coal mines in the Bellingham and Lake Whatcom areas. Coal seams are found throughout this formation, but most productive are the basal Bellingham Bay member, which hosts coal in the Blue Canyon mine in the southern portion of the landscape planning area, and the uppermost Padden member which hosts coal seams mined in the Bellingham and western Lake Whatcom coal zones.

Coal seams exploited ranged from an average thickness of 4 to15 feet thick, and were of generally good quality. Several historic coal mines are located in the Lake Whatcom landscape planning area. There are at least four mines that have reported some past coal production in the planning area. These mines were all underground operations. They are, in general, relatively small, but indicate the potential for other subsurface coal deposits under much of the Lake Whatcom landscape planning area where these formations are present at the surface, or in the subsurface below glacial cover. Reserve estimates for these mine areas have been indicated in several reports.

Measured and inferred coal reserves have been determined in the Lake Whatcom coal zone covering the western third of the lake and extending along an area up to two miles to the southwest of the lake shore, and in the Blue Canyon coal zone in the southern end of the lake. Estimates of coal reserves are, respectively 50 and 95 million tons, much of which underlie the landscape planning area. Very little drill testing has been reported from this area and the extent of the coal seams is uncertain. Folding and faulting, as encountered in past mining, may limit access to at least some of the potential resources. Erosion and/or faulting may have removed potential coal horizons in some areas within the landscape planning area.

It is a matter of conjecture whether these deposits will become economically feasible in the future. Energy demand and price may make these resources attractive at some point, but these resources are not believed to be economically feasible at this stage. Potential uses for this coal are direct coal uses and coal gasification (that is, converting coal into other combustible materials rather than direct use of the coal. Leasing of these lands for coal exploration and development would be done at the discretion of DNR or, at the discretion of the owner of the mineral estate, as the case may be.

Because of the depth of the coal seams, strip mining would likely not be considered as a method of coal removal for economic and environmental reasons. Underground mining would limit impacts to the viewscape and minimize habitat related issues, but groundwater quality impacts could be a potential issue.

Oil and gas:

Closely related to the coal occurrences in the Lake Whatcom landscape planning is the potential for natural gas (methane). Gas occurrences commonly are related to coal occurrences, particularly if the coal has a highly volatile content as the Lake Whatcom area coal tends to be. Gas shows in drilling generally occur in the Eocene Chuckanut Formation and in the Huntingdon Formation of Eocene to Oligocene age in the Lake Whatcom area. Both units are folded in the landscape planning area, which may provide stratigraphic traps for gas accumulation.

Several gas occurrences are known in the Bellingham-Lake Whatcom area. Gas was encountered in water well drilling in the area, and reportedly gas trapped in the overlying Pleistocene clays has been locally exploited for home use in the area north of Bellingham. However, the only well with significant gas show was near Ferndale. These occurrences and the occurrence of oil seeps in the Bellingham area have attracted oil and gas exploration activity to the Lake Whatcom-Bellingham area in the past. Several exploration drill tests have been completed near the landscape planning area

There have been only a few drill tests within the landscape planning area. Of these, two wells within the management area tested positive for gas. Currently there are two active oil and gas leases on state land in the Lake Whatcom management area. (The first lease expires in 2006. The other lease expires December 31, 2002.)

Interest in coal-bed methane gas has stimulated recent leasing and drilling activity in other areas of the state where coal occurrences are present. Coal bed methane exploration activity has been of recent interest in other coal districts in the state. Interest in the Bellingham-Lake Whatcom could lead to additional drill testing in the near future.

There are no known oil occurrences in or near the management area. However naturally occurring oil seeps have been noted in Bellingham. There is a possibility of oil potential within the landscape planning area, but should be considered low, as no significant oil shows have been found in past exploration drill testing in or near the area.

Hydropower:

There is no current or potential hydropower resource within the landscape planning area.

<u>Mineral Resources</u>

Sand, gravel and rock:

The geology underlying the management area limits the availability of high quality, high volume sand and gravel or rock deposits for use as construction aggregate materials in the planning area. Glacial outwash deposits, which often produce high quality construction aggregate, are limited in the landscape planning area. Pleistocene Sumas Stade outwash deposits, which host many of the larger deposits in the region, are present in the lowland between Squalicum Mountain and Stewart Mountain. A number of small pits have been developed in these glacial deposits for road construction material, such as forest road use, or use in other road construction. One gravel pit operated on private surface as a commercial operation for concrete aggregate material. The size, quality and location of these deposits limit the potential for a large-scale gravel operation in the landscape planning area. However, there is the possibility of a small-scale commercial gravel operation in this area. The potential for commercial gravel opportunities appears to occur on private surface and not on DNR-managed land.

Other small borrow pits were developed in glacial material near the South Bay. For the most part, Washington State Department of Transportation (WSDOT) developed these pits as borrow pits for road construction or maintenance.

Similarly, WSDOT developed several small borrow pits in sandstone, phyllite and shale bedrock within the landscape planning area. In all cases, these were small pits used for road fill material.

DNR has extracted rock within the landscape planning area for forest road construction and maintenance related to timber harvest activity. These generally are small borrow pits of less than one acre in size. New pits of this nature would be constructed in a manner to comply with all HCP conditions and Forest Practices rules.

There are no Growth Management Act (GMA) mineral lands designated within the landscape planning area. Any gravel or rock development other than for forest use would likely need a conditional use permit and possibly a rezone in order to develop a commercial gravel or rock site within the landscape planning area.

The Chuckanut sandstone has been used in the past used as building stone. This use was mainly during the 1800s and other building materials have since replaced its use. Chuckanut sandstone underlies much of the landscape planning area according to the geologic map. There are no known sandstone quarries in the landscape plan area. This material not likely will be exploited in the foreseeable future because of limited demand, and sources elsewhere.

Metallic minerals:

There are no known or reported metallic mineral deposits or occurrences in or near the Lake Whatcom management area. The bedrock units and geologic framework underlying the planning unit are not conducive for the formation of metal deposits.

Industrial minerals:

Bentonite clay deposits occur within the Chuckanut formation interbedded with sandstone and shale. One occurrence is located on Lookout Mountain. However, this bentonite is reported to be a non-swelling type that has little commercial application.

Other glacial clay deposits in the general area have been used for tile and brick, and for use in cement. Clay deposits have been noted near landscape planning area in drill holes. No deposits have been developed in the landscape planning area and it is not likely that any would be exploited here, as the demand for this material is limited.

Forest Resources

Timber Resources:

Information about existing timber resources comes from the department's Forest Resource Inventory System (FRIS). Inventory was conducted on lands within the project area in 1995. Over 80 percent of the state trust forest stands are of commercial size in the medium and large saw timber size classes.

Table 10: Approximate percent of state trust lands by commercial timber size class.

Size Class	Approximate Age	Percent
Seedling/Sapling	0-20	13
Pole Timber	20-40	5
Medium Timber	40-70	50
Large Timber	70+	31
Non-forested		1
Total		100

Douglas-fir is the primary species on more than 50 percent of the project forestland. Commercially sized red alder dominates approximately 22 percent of the stands. Western hemlock is most prevalent in 20 percent of the planning area, primarily at higher elevations. Stands dominated by western red cedar and Pacific silver fir are roughly 5 percent and 1 percent, respectively. Other commercial species include black cottonwood, big-leaf maple, and western white pine.

Current state law and department policy require the department to manage state forestlands to produce a sustainable, even-flow harvest of timber, subject to economic, environmental, and regulatory considerations (Multiple Use Act, ch.79.68 RCW; Forest Resource Plan Policy # 4). The department implements its policy by setting harvest levels over a ten-year period. The anticipated minimum rotation age for regeneration harvests on westside stands is 60 years; however, to meet specific objectives, the department may cut stands as young as 45 years old or stands older by several decades.

For commercial harvests the department utilizes regeneration harvests, intermediate pole harvests, small wood thinnings, and partial cuts. The most common harvest method used in the project area has been regeneration clear cuts, a system that removes all of the volume in an existing commercial timber stand during harvest with the exception of reserve trees and snags left under green tree retention.

Intermediate harvests of cedar and Douglas-fir poles are practiced where specific site and stand conditions are met. Trees must meet pole specifications for straightness, uniform taper, adequate sapwood, and absence of sucker knots. Terrain suitable for ground-based equipment offers the best opportunity for intensive pole management; economic considerations may require a minimum of least 9 poles per acres in a stand of at least 20 acres in size. Preliminary investigation of stands within the project area indicates few stands eligible for pole harvest.

The focus of commercial thinnings is maintenance of a high growth rate in stands by manipulation of stocking levels and without reduction of the total value of the stand over the expected rotation. The emphasis of a late thinning or partial cut is the intermediate removal of volume from stands without compromising the commercial characteristics of the residual stands.

Factors significant to successful commercial timber harvests include suitable and reasonable access to sites, sufficient quantities of wood to support economically viable harvest operations, and timber of suitable size and quality. A related, and important impact to successful harvest is the choice of logging method. Cable and ground based systems are the most commonly used with ground based yarding limited to slopes under 30%. Helicopter yarding is utilized where road access is unavailable. The practicality of using helicopters is primarily a function of flight distance and elevation between the logging unit and log landing area; yarding distances beyond ¾-mile downhill or ¼ mile uphill make use of helicopters unfeasible.

Special Forest Products

Special forest products are forest products other than timber that are harvested for a variety of personal and commercial uses such as edibles, floral products, Christmas greens, and pharmaceutical extracts, e.g., Cascara bark, Pacific yew, St. Johns wort. The harvesting of such products began with centuries of cultural and subsistence uses by Native Americans and eventually by European immigrants, and has expanded into today's small and large-scale commercial production with worldwide markets.

Elements critical to the success of management, harvesting and marketing of commercial special forest products are: 1) access necessary to remove a commercial volume of a product in an economically feasible manner, 2) the quantity needed to support an economically viable harvest operation and, 3) quality products that meet commercial standards. Other related factors include harvest site in relation to slope, product density, distance to market and road conditions, exclusive vs. non-exclusive harvest sites, and disease and insect damage.

Economically important forest products specific to the project area are:

Floral Greens: Of the commonly marketed greens, salal, sword fern, and scotch broom are found in the planning area. Of these, only sword fern is in sufficient commercial quantity. There is currently a very marginal and low paying market for sword fern. The florist industry prefers higher quality ferns grown in greenhouses.

Christmas Greens: Christmas greens include boughs from Pacific silver fir, Douglas-fir, western white pine, and western red cedar. There is a fair quantity of western red cedar boughs, especially in the western portion of the planning area. The boughs need to be dark green, which occurs in shadier stands. Cedar grown in more open, drier sites have yellow, lighter colored needles not of commercial quality.

Mushrooms: Common commercial mushrooms are Morels, Matsutake, and Chanterelles, all of which require specific forest conditions to support commercial quantity levels. Though wild edible mushrooms are known to exist in the planning area, quantities are believed to be insufficient to support commercial harvesting. DNR has offered commercial mushroom permits in other parts of the state but with limited success.

Moss: Moss needs to be clean of conifer needles and in thick clumps. While there is extensive moss in the planning area, commercial quantity and quality are low.

Medicinal plants: Medicinal plants include Princess pine, St. John's wort, and valerian among others. Market potential for medicinal plants is unknown at this time, though research may result in the discovery of new potential uses. The amounts and types of medicinal plants on the project have not been identified.

Transplants: While there is value and demand for native plant transplants, many of these plants are now being grown in nursery conditions. Northwest Region currently issues one annual permit for digging up native plants in planned timber sale and road construction areas throughout Whatcom and Skagit counties.

Special forest product specialists within the department believe the Whatcom County area does not have the volume of high quality products to support extensive commercial markets. Of the products currently commercially marketable in the planning area, only western red cedar boughs have good revenue potential.

<u>Conservation/preservation</u> (carbon sequestration)

The term forest "carbon sequestration," also called "carbon offset," refers to a forest's ability to store carbon and counterbalance carbon dioxide emissions. Forests balance the amount of carbon dioxide (CO2) in the atmosphere because they act as "sinks," drawing carbon dioxide out of the atmosphere through the process of photosynthesis. They convert the carbon dioxide into substances such as carbohydrates, which provide a store of energy (i.e., leaves, branches, bark, etc.). Carbon dioxide is released back into the atmosphere when plants respire and through the process of decomposition.

Sequestering carbon and selling "carbon credits" could be a source of income to the trust beneficiaries. Carbon credits work by paying landowners to keep a certain amount of carbon (i.e., trees) in long-term or permanent storage. Utility companies or heavy industry can then buy those credits to offset their carbon-dioxide emissions.

The potential for carbon sequestration and DNR's ability to sell carbon credits to generate revenue for the trusts is discussed under "Impacts to the Trust" for each alternative.

Scenic Resources

Scenic views tend to be limited by forest canopies. Views generally occur with isolated outcroppings or in areas where roads, harvesting or amenities create openings in the canopy.

Potential scenic views exist on Lookout Mountain and Stewart Mountain (of Bellingham and the watershed) and the North Shore trail (lake and mountains). Currently road access to and across state land is gated. In addition, the quality of existing roads does not meet public travel needs. Also, the points have not been managed to maintain views.

Built Environment (4.1.2)

ENVIRONMENTAL HEALTH (4.1.2.1)

Release of Toxics/Hazardous Materials

Road access to and across state land is gated, which reduces the risk of abandoned vehicles, garbage, and oil and other fluid spills. Communication-site lessees and logging contractors use the gated road system, which could leak minor amounts of oil and fluids.

Methamphetamine labs are becoming increasingly common in forested areas easily accessible from adjacent urban areas, where traffic and other activities are less frequent. No incidents have been reported on state trust lands in the planning area.

Risk of Explosion/Fires

The June 1998 Olympic Pipeline incident has increased public awareness and concern about the risk of explosion but the risk in the planning area is very limited. The comprehensive plan map of natural gas and oil transmission and natural gas distribution routes shows natural gas distribution lines to customers at the north end of the Lake Whatcom watershed. Oil transmission lines are located beyond the west side of the planning area.

Fire risk in the forested areas of the watershed is related to natural causes (such as lightning strikes) or human causes (such as improperly tended or unextinguished camp fires). Please see “Air,” Section 4.1.1.2. Seven wildfires, all less than one acre, occurred in the Lake Whatcom watershed between 1970 and 2000.

Risk of Slides, Floods, Debris Flows

Significant debris flow events occurred along the incised channels prior to development of the area. Some of the flows were larger than those that have occurred since the initiation of timber harvest. Damaging, destructive debris flows will continue to occur in many of the drainages in the planning area. There will be a continuing threat of property damage and potential loss of life to people occupying the channels and alluvial fans of these drainages.

Spiritual & Emotional Health

Some participants in the scoping process emphasized the importance of forests to their spiritual and emotional health. Identifying and interpreting value of forests to spiritual and emotional health is highly varied among individuals. This makes evaluating the impact of forest management activities on spiritual and emotional health very subjective and difficult to extrapolate to a larger population. DNR is unaware of any existing surveys or other data relating to spiritual and emotional health values held for Lake Whatcom. This will not be analyzed under the alternatives.

LAND & SHORELINE USE (4.1.2.2)

Existing Land Use Plans/Growth Estimates

The Whatcom County Comprehensive Plan sets the land use vision and goals for all but the southern tip of the planning area, which extends into Skagit County. Some of the land in the northwest portion of the Lake Whatcom planning area falls within the county’s urban growth boundary, including an area of the city of Bellingham abutting the lake. The rest, including all state trust lands, are outside the urban growth boundary, where population densities are lower and land uses more rural in character.

According to the Whatcom County Comprehensive Plan, typical uses in the rural areas “include a mixture of low-density residential, pasture, agriculture, woodlots, home occupations, and cottage industries. The distribution of rural land use is adjacent to agricultural, forestry, and urban land uses and often provides a buffer between urban areas and commercial agriculture and forestry uses." (1997)

Techniques for maintaining rural character include clustering development and allowing density transfers between parcels in rural areas and from rural areas to Urban Growth areas. These techniques meet the comprehensive plan goals to provide economic flexibility to individual property owners, conserve natural resources and environmentally fragile areas, and retain future options with respect to land use decisions. During development of the comprehensive plan, participating citizens indicated they would like to see 75 percent to 90 percent of the land (excluding National Forest and National Park land) in Whatcom County zoned for use as rural, forestry and agricultural lands. Zoning in place in early 2002 would achieve 90 percent of that goal.

Land use designations in the Lake Whatcom watershed include commercial forestry, rural forestry, mineral lands, rural, suburban enclave and public/recreation. County development regulations outline permitted uses for each of these designations. The county designated most of the DNR-managed property within the planning area as commercial forestland of long-term significance.

Whatcom County's population as of April 1, 2001 is 170,600, with approximately 95,000 residents living in incorporated cities and towns. The 1990 census counted a total of 127,780 residents, 68,593 of these lived inside the city limits of the county's seven incorporated cities.

Whatcom County projects a 2015 total count population of 220,366 people, based on an assumption of a two percent average annual increase. This corresponds to the state Office of Financial Management's high projection for the county and reflects that actual growth has consistently exceeded OFM projections. For instance, between 1990 and 1995 the population increased at a rate of 3.02 percent per year. To avoid tightening the urban land supply and consequently raising housing costs, the county and its cities agreed to set urban growth boundaries which could accommodate at least 50 percent greater than the anticipated need.

Residential and Commercial Development

There is presently no residential development on state trust lands in the planning area, and commercial development is limited to three communication sites.

City of Bellingham neighborhoods located within the watershed include the Alabama Hill and Silver Beach neighborhood planning areas, and to a lesser extent the Whatcom Falls and Mt. Baker neighborhood planning areas. Land use in these areas primarily is allocated for single and multi-family housing, with limited areas of commercial and public zoning.

Within the Whatcom County portion of the watershed approximately 70 percent of the land is zoned commercial and rural forestry, while 13 percent of the land is zoned residential and 16 percent is zoned rural. Assessor data from 1999 showed residential use occurring on 10.3 percent of the land within the planning area and commercial development or uses occurring on 0.8 percent of the land.

Allowable densities of development vary for the residential zoning categories, with minimum lot size and maximum density for new construction dependent on the availability of public sewer and water service. Under present zoning, the densities range from a maximum of 12 units to the acre in certain areas with urban services to a minimum of one dwelling unit per 40-acre parcel in the rural forestry zone. In addition to residential zoning for the City of Bellingham lands within the watershed, three County areas also are zoned urban residential. These are Sudden Valley, the Geneva Urban Growth Area and the County Fringe Urban Growth Area.

Potential Future Growth

No residential development is expected on state trust lands due to current zoning.

The Whatcom County Council on June 18, 2002, passed an interim zoning ordinance "to avoid further degradation of the Lake Whatcom watershed and the associated threat to the drinking water supply of approximately half the citizens of Whatcom County." (WCC Ordinance #2002-036) The ordinance, to be in effect for six months with the possibility of one or more six-month extensions, downzones the development of a number of areas within the watershed. It sets new lower levels of one dwelling unit per five acres in areas previously zoned to allow one unit per acre or one unit per two acres. Urban Residential 3 designations in the Geneva and Hillside Bellingham Urban Growth Areas are changed from three units to two units per acre and will require concurrence with the City of Bellingham. All parcels greater than 12,000 square feet within the Urban Residential 3 zoning designation in the Sudden Valley Growth Management Area are reduced to one unit per five acres, as are all similar zoning designations within the watershed southeast of the Sudden Valley Association area.

The interim ordinance was adopted to restrict the number of buildable lots within the watershed, estimated within the ordinance at approximately 3,250 under the zoning in force at the time the ordinance was proposed.

<u>Aesthetics</u>

The "visibility" of forestry operations is influenced by several factors, including: the position and distance of the viewpoint from the activity, the topography of the land, the type of operation, and the intensity and/or concentration of activities. The reaction to that visual impact as negative or positive depends on the values and background of the observer as well as what is revealed and/or remains hidden as a result of the activity, and how long the view is in front of the person.

State trust lands are visible from a variety of locations throughout the watershed (Visual Impacts Assessment, 2001.), including:

- Residences
- Parks and trails (specifically Bloedel Donovan Park and the North Shore Trail)
- Recreational sites (Sudden Valley golf course)
- Boaters on the lake
- Vehicles driving on county and city roads
- Vehicles driving on forest roads

The people who see these viewsheds most often and for the longest duration are the local residents. The main concentration of residences in the watershed can be identified as: Northshore, Southbay, Sudden Valley, Bloedel, Smith Creek, Geneva, and Cain/Reed. When topography, distance and other land features are considered, general areas of state trust lands can be identified as being "moderate" or "high" visibility from these residential areas. (See Map S-1.) These mapped residential viewsheds will be used for the comparative analysis of the five landscape plan alternatives. (Visual Impacts Assessment, 2001.)

When Map S-1 was originally created for the visuals assessment, riparian buffers and unstable areas were removed from the map since it was assumed they would remain forested. In reality, the trees in riparian areas and on unstable slopes provide visual screens to adjacent lands as well, and the variation in these will be a factor in comparing impacts of each alternative.

Map J-1 shows the distribution of forest on state trust lands by age class as of May 2002.

<u>Recreation</u>

Current recreational use is informal and dispersed. Hiking, hunting, mountain biking, horseback riding, mushroom and berry picking, and bird watching are typical activities. There are no developed camping facilities or DNR-managed trails on state trust lands within the planning area.

Hiking: The 1200 mile Pacific Northwest Trail, running from the Continental Divide to the Pacific Ocean, crosses the planning area in the southernmost end. This trail passes through the Rocky Mountains, Selkirk Mountains, Pasayten Wilderness, North Cascades, Olympic Mountains, and Wilderness Coast. The trail crosses three national parks and seven national forests. A trail map on an Internet website shows the trail passing through DNR-managed land but no formal sanction or easement has been issued.

Hikers also have access to three miles of lakeshore via the North Shore Trail (see Map R-1).

Sudden Valley has a small network of trails within boundaries of the development. The trails are generally within green belts and connect park areas. A small volunteer trail maintenance program is being formed by Sudden Valley recreation staff and has generated some interest. Some trails link to DNR managed roads south of Sudden Valley ownership. Residents of Sudden Valley walk on these roads. No trails (sanctioned or non-sanctioned) are known to exist on the adjacent DNR lands.

Mountain biking: Mountain biking activity within the planning area has increased dramatically within the past several years and will likely continue to increase. Local enthusiasts have formed a mountain-biking club and have been very active in construction and maintenance of a trail system on Galbraith Mountain in the western part of the landscape. Most of the trail system is on private lands (Bloedel, Trillium) with a little use on state trust lands near the Galbraith Mountain communication site. The capacity of this trail system has been stretched for a number of reasons:

1. Increasing interest in the sport.
2. Accessibility to a population base. The trail system on Galbraith Mountain is one of the few in the western states that is accessible "from our backdoor." Most require bikers to drive to a site before starting their ride.
3. The Galbraith site has been featured in nationally distributed publications resulting in interest from outside the local community.
4. Motorcycle use of the area has increased with some resulting conflict.
5. Mountain bike use is restricted or prohibited in other areas (Forest Service wilderness, NRCAs, national parks, state parks). Many of these restrictions are recent changes in policy.

These pressures will likely result in mountain bikers looking to expand the existing trail systems or create trail systems in other areas. While aesthetics and natural beauty are important to mountain bike enthusiasts, access is of primary concern. This is especially true in areas such as Blanchard Mountain where an effort to convert trust lands to an NRCA (mountain bikes are prohibited in NRCAs) is ongoing. Recreation planning would result in decreased conflict between user groups if objectives for recreation in the area are clear.

Access to private and public lands for mountain biking varies greatly depending on ownership and landowner objectives for their land.

Equestrian use: Horseback riding is popular on state lands on Stewart Mountain though the trail system is unsanctioned. Members of the Whatcom Backcountry Horse-riders Association actively use and maintain this trail system. In 2000, Whatcom County Parks constructed a horseback riders trailhead facility off Y Road, which is used to access trust lands north of Lake Whatcom. Equestrians utilize existing logging roads and abandoned roads as well as trails. Use of roads is year-round while trail use is generally during summer months when soils are not as saturated.

Off-road vehicle use: Off road vehicle (ORV) use has been discouraged because it heightens the potential for resource damage in watersheds where water quality is critical. ORV use can result in damage to forest roads requiring expensive repair. The primary method of discouraging use is through personal contact with, and environmental education of, ORV operators. Gates block access to major forest road systems, in cooperation with other major landowners or local governments. When necessary, enforcement action is taken to protect public resources and trust assets.

Historic & Cultural Preservation

There is considerable evidence that the Lake Whatcom Watershed has prehistoric, historic, ethnographic, and current use areas of interest. The majority of the prehistoric and historic materials are probably near the lakeshore. However, inland prehistoric and historic properties as well as current use areas occur in the records and in Tribal Records and will be found in the planning area.

A partial listing of known cultural resource types in the Lake Whatcom watershed is presented in the table below. This table also indicates whether such properties are currently being used and which will be used in the future. Not all of these cultural resource types are known to exist on state trust lands. These cultural resources include archaeological and historical sites as well as those cultural resources of concern identified by the Lummi Nation. The Nooksack Tribe did not participate in the identification process.

Traditional named places, legendary sites, ritual bathing sites, and spirit quest sites are known as Traditional Cultural Properties (TCP). These are sites or localities that are important in maintaining the culture of a group or tribe. These property types are not mutually exclusive; for example, a legendary site, which has also been used for gathering medicinal herbs and which also may show ancient manifestations of that gathering and may therefore be an archaeological site.

Table 11: Cultural Resource Types in the Lake Whatcom Watershed

Property Type	Historic (H) or Current and Expected Future Use (C)
Archaeological Sites—further divisible into prehistoric, protohistoric, and or historic	H
Historic Buildings	H/C
Culturally Modified Trees (CMTs)	H/C
Traditional Named Places	H/C
Hunting and Gathering Sites	H/C
Ceremonial flora/medicine sites	H/C
Ritual Bathing Sites	H/C
Gear storage sites	H/C
Caves	H/C
Burials—further divisible into cairns and tree burials	H/C
Trails	H/C
Petroglyphs	H/C
Spirit quest sites	H/C
Totems/Canoes	H
Old Growth	H/C
Wildlife	H/C
Fish	H/C
Shipwrecks	H

Many of these sites are related to past, present and future Native American spirituality and religious practices. Among many Native American groups these were and are the most intensely personal and private matters imaginable. Therefore, there is understandable reluctance among the Tribes and Nations to share the locations of these sites and information on activities that occurs there. However, this reluctance to reveal locations makes protection of the resource extremely difficult. There is a tension between a land manager's needs for specificity of site location and tribal member's needs for secrecy.

Known cultural resources are either recorded or unrecorded. The Lummi Nation and the Nooksack Indian Tribe maintain an extensive listing of cultural resource properties within ceded lands and usual and accustomed areas. Tribal policy is to not share this information. Since these sites are not listed on the Washington State Inventory of Historic Places, they are considered not recorded for state land management purposes.

Recorded sites, if they have been evaluated, are documented as significant or not significant. It is assumed additional cultural resources exist in the landscape but are unknown. An historic property can be of intense significance to an individual or small groups of individuals. However, for the purpose of this discussion (and in cultural resource management generally) sites are considered "significant" only if they are included on the National Register of Historic Places (NRHP), are eligible to be on the NRHP, or are potentially eligible to be on the NRHP. Although state and local registers do exist, the NRHP is the standard in cultural resource management. Only “significant” properties are protected under state and federal law. No cultural resource in the planning area has been evaluated for inclusion on the National Register of Historic Places.

These categories are illustrated in Figure 2, and discussed further in the Cultural Resource Assessment. (See Appendix D). Appendix D also provides details about the prehistory and history of the planning area.

Figure 2. Cultural Resource Properties Categories.

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                      Universe of Cultural Resource Properties------------
                      /                        \                  \
                     /                          \                  \
           Known-Recorded          Known - Not Recorded         Unknown
         /        |        \                                           /\
Significant   Non Significant   Not Evaluated              Significant   Non Significant
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Data Gaps

The cultural resource data gaps in the planning area are enormous. The major data gap is the lack of information from the Nooksack Tribe. This is mitigated somewhat by the intermarriage that has occurred between individuals from the Lummi Nation and the Nooksack Tribe. The Lummi Nation’s data cannot be considered exhaustive as individual tribal members may choose not to identify sites to the tribal government or to any outside entity.

The lack of prehistoric and historic sites in the Lake Whatcom watershed is not surprising. Only one small cultural resource survey has been completed within the boundaries of the planning area. There is no information on underwater archaeological sites.

Agriculture

Significant agricultural use is not anticipated since none of the lands designated in the Whatcom County Comprehensive Plan for long-term agricultural significance lie within the Lake Whatcom planning area. However, agriculture is a permitted use for the land zoned rural residential. The Skagit County lands within the southern tip of the planning area are designated for forestry use.

Silviculture

The department implements a range of silvicultural practices including natural and artificial reforestation, chemical and mechanical site preparation, vegetation control, fertilization, pruning, precommercial and commercial thinnings, partial cuts, and regeneration harvests. Non-commercial activities are those that may alter the biological composition of a stand but will not involve commercial commodity production or removal from the site.

Site preparation encompasses activities that ready sites prior to reforestation. These methods include burning, mechanical or manual clearing of brush, and herbicide use. These activities will differ depending on the method of regeneration to be used. The department seldom practices prescribed burning – once a common practice – although burning of debris piles created by logging is occasionally conducted during winter months. Mechanical site preparation is conducted with ground-based equipment during harvest activities and is generally limited to fire hazard abatement, creation of planting spots, and the removal of vine maple clumps. Herbicide applications are used only when deemed necessary to ensure plant establishment and seedling survival.

Reforestation occurs through a combination of planting and natural regeneration. Most prescriptions for the project area comprise a mix of Douglas-fir and cedar. At elevations above 2000 feet, natural seeding of hemlock and pacific silver fir is the most effective method of reforestation.

To control competing vegetation that may hinder tree growth within existing plantations, the department uses a variety of mechanical and herbicide techniques. Some of the brush species to be controlled include alder, cottonwood, salmonberry, bigleaf maple, and elderberry. To date, the majority of control measures in the project areas have employed the use of hand-slashing for the removal of most brush. Chemical treatments have been limited to ground-applied herbicide for the control of bigleaf maple.

Stand improvement activities, pruning, fertilization, and precommercial thinning, are encouraged if these activities can provide acceptable rates of return (Forest Resource Plan Policy # 34). Precommercial thinning involves the manipulation of the number of desired trees on a site. Stocking of preferred species is also controlled. Precommercial thinning is routinely practiced in the Northwest Region; pruning and fertilization are not.

For commercial harvests the department uses both even-aged and uneven-aged silvicultural systems. These systems are generally defined by the reproduction method by which a stand is established or renewed (Smith 1986) Even-aged harvests in the form of regeneration clearcuts with artificial planting have been the most common system used in the project area. This type of harvesting is used primarily for the regeneration of shade-intolerant species such as Douglas-fir and red alder.

Commercial small wood thinnings typically occur in stands with little crown differentiation where spacing and/or stocking guidelines are the primary method of tree selection. This is different from late thinnings or partial cuts where individual tree characteristics are typically the primary means of tree selection. Partial cuts, which leave more than 50 trees per acre, are considered a form of uneven aged harvest and tend to favor shade-tolerant species such as hemlock.

TRANSPORTATION (4.1.2.3)

Transportation Systems

Roads are constructed primarily for timber harvest. Those roads remain active if there are further management activities planned in the vicinity. Roads may also be used for access to electronic sites and powerline maintenance. Some people also use these roads for recreational walking, horseback riding, or mountain biking. Occasionally, easement rights are granted to neighboring landowners to construct road on DNR managed land to facilitate their management activities.

Gates restrict access year round to all DNR roads in the Lake Whatcom watershed. This is done to prevent vandalism, damage to roads, and to protect water quality.

There are currently 44 miles of active forest roads and 42 miles of orphaned roads on DNR ownership in the planning area. Orphaned roads are roads or railroad grades that have not been used for forest practices activities since 1974. Many of these roads are over-grown or closed off, but have not satisfied the abandonment process.

Work done on existing roads can be described as "maintenance" or "reconstruction." Maintenance typically involves brush-cutting, grading, clearing of ditches, or other minor upkeep to the existing road prism. ("Road prism" describes the cross section of the road including the traveled surface, ditch, cutbank, and fillslope.) Reconstruction describes more extensive work than routine maintenance. The road geometry may be adjusted in some way or drainage structures installed. In practice, there is some overlap in what may be maintenance or reconstruction.

Forest Road Maintenance and Abandonment Plans

DNR roads that are no longer needed are abandoned to Forest Practice legal standards. Work is done to restore natural drainage, prevent erosion, and prevent vehicle access.

Roads built in the past were under different legal requirements and design standards. They may have poor drainage, inadequate surfacing, over-steepened cutbanks or fillslopes, or organic material in stream crossing fills.

Washington law (WAC 222-24-051) requires that forest landowners assess all active and orphaned roads on their ownership by 2005. All active roads must meet current legal standards by 2015. As road systems are assessed, landowners submit a plan for accomplishing the maintenance and abandonment work. This plan is referred to in the Forest Practice laws as a Road Maintenance and Abandonment Plan (RMAP).

RMAPs are developed to be consistent with the road management strategy in DNR's Habitat Conservation Plan (page IV.62).

Traffic patterns

Roads on DNR managed land often continue onto private ownership. Neighboring landowners may also contribute to traffic on DNR managed roads. Legal easements govern the use of these shared roads.

Traffic generally consists of trucks hauling logs and rock. Roads that access communication sites or other utilities may be frequently used for maintenance of those facilities. Vehicles travel from the DNR road network to their destination using public roads maintained by the state, county, or city.

The forest road network joins with public streets at many points. Trucks that leave DNR lands via North Shore Drive or Y Road would travel north to the Mount Baker Highway and either head west to I-5 or east, depending on their destination. Trucks using Turkington Road, Park Road, and DNR mainlines on the hills above Park Road eventually intersect with Highway 9 and head north into Whatcom County or south through Sedro Woolley. Trucks entering Lake Louise Road typically travel to I-5 via Lakeway or north past Bloedel Donovan Park to Britton Road. Some traffic from Lake Louise Road may go east on Lake Whatcom Boulevard, but a bridge with weight restrictions limits loads on this route. On the very south end of the planning area, timber may be hauled to the Skaarup Road and continue either west to I-5 or east to Highway 9.

Traffic using these routes may travel through populated areas of Whatcom County, including North Shore, Acme, Geneva, Sudden Valley, Cain Lake/Glenhaven, and Alger communities. Several of the routes pass through one or more school zones. The level of traffic on a particular road varies, depending on where forest management activity is occurring. This traffic is also seasonal in nature, with more truck trips occurring during drier weather.

Other public roads that may be affected include: Camp 2 Road, Manley Road, Squires Lake Road, and the access to the Whatcom County rifle range. These areas have had little timber haul from DNR lands in the past but could experience increased traffic, depending on the harvest level and road construction options that are chosen.

Logs are typically hauled to mills in northwest Washington, but have occasionally been taken to eastern Washington or Oregon. Due to the poor supply of durable rock nearby, rock for road construction is hauled from pits in the Whatcom or Skagit County lowlands, Lummi Island, or nearby foothills.

Water, Rail and Air Traffic

DNR management of its lands within the Lake Whatcom watershed, regardless of the alternative selected, will not have a significant impact on water, rail or air traffic. Products from DNR lands will be transported by truck and no railroad lines pass through the planning area. Helicopter logging will be considered in harvest planning, with minimal effects on air traffic.

PUBLIC SERVICES & UTILITIES (4.1.2.4)

Relation to Trust Income

State trust lands in the Lake Whatcom Landscape generate revenue for seven different trusts. The number of acres in each trust is shown below:

Table 12: Acres by Trust in Lake Whatcom Landscape

Trust	**Acres**
Forest Board Transfer Lands (Whatcom County)	8,423
Forest Board Transfer Lands (Skagit County)	690
Forest Board Purchase Lands	881
Common School	4627
Agriculture School	193
Capitol Buildings	286
Scientific School	557
Total trust acres	15,647

Forest Board Lands provide revenue that benefits the state general fund and supports County services through junior taxing districts.

Timber harvesting within the planning area has generated approximately $14.7 million in revenue over the last 20 years. Of this total, approximately $ 10.25 million was from Whatcom Forest Board lands, $1.25 million came from Skagit Forest Board lands and approximately $3.2 million came from Federal trust lands. It should be noted this past level of revenue generation is not reflective of what could be generated in the future under any of the alternatives for a number of reasons. Revenues were generated from a much smaller land base prior to 1993. In 1993 a land exchange approximately doubled the acreage of DNR managed land within the planning area. Also, timber prices vary over time and significantly affect the revenue stream even if the amount of timber harvested remains the same. In 1999, legislative restrictions on selling of timber within the watershed went into effect, and a moratorium on timber harvest, pending completion of the landscape plan, has been in effect since June of 2000. These two actions eliminated additional revenue over the past two years.

In addition to timber harvest, the department has been researching the following revenue mechanisms. However, since none of these are active at the present, they are not part of the "baseline" assumed for Alternative 1 when comparing income among the alternatives in Section 4.

Fire Protection Services

Fire protection is provided on improved property by four Whatcom County fire districts. They include No. 2, Geneva/Sudden Valley; No. 4 Bellingham; No. 10 Bellingham; and No. 18, South Lake Whatcom. These districts may also provide emergency medical response in the planning area.

DNR provides fire protection to state and private forestland. In the event of large wildland fires multi-agency teams of local, state and federal partners cooperate in firefighting efforts.

Police

The Bellingham Police Department provides police protection and services to all areas within the city limits of Bellingham, including the neighborhoods at the northwest corner of the planning area. The Whatcom County Sheriff's jurisdiction includes all county lands within the planning area. The Sheriff's patrol boat provides protection and handles incidents that occur on Lake Whatcom. The Skagit County Sheriff covers the limited amount of Skagit County lands on the southern edge of the planning area.

Schools

Two school districts serve students in or near the Lake Whatcom watershed, Bellingham School District No. 501 and Mt. Baker School District No. 507. The following Bellingham schools are located within the planning area: Silver Beach, Geneva and Northern Heights (opening fall 2002) elementary schools and Squalicum High School. Mt. Baker School District students who live in the Cain Lake area within the watershed attend Acme Elementary School and Mt. Baker Junior High School/Mt. Baker High School in Deming. Students are transported through the planning area to each of these schools.

Parks & Recreation facilities

There are no developed recreation facilities on DNR land including camping facilities and formal hiking trails. In the Lake Whatcom watershed, there are several facilities that serve the surrounding community. The following is an excerpt from the Lake Whatcom Water Source Protection Plan, April 2000, which describes the current facilities found adjacent to trust lands within the planning area.

"Lake Whatcom is the largest lake in Whatcom County and as such, this lake and surrounding watershed provide ample recreation opportunities. Non-lake resident recreational use is concentrated at Bloedel-Donovan park . . ."

Portions of the city's Whatcom Falls Park abut the watershed to the west. The City also holds an undeveloped parcel on Euclid which is classified as a natural open space area. The County owns five parcels of parkland/undeveloped parkland in the Lake Whatcom watershed. Lakeshore areas are accessible to the public along the Northshore trail. Above the trail, in the Smith Creek area, the county holds a 245-acre parcel, which is currently undeveloped. (2000)

In addition to public access points, there are also many private docks, swimming area, several launching area and camping areas on Lake Whatcom. There is on on-lake boat fueling area located in basin three. A marina at Sudden Valley provides boat moorage and dry storage. There is a seaplane airstrip with airplane chartering and two hangars. Sudden Valley Golf Course was developed in1969 on lakefront property that was previously used as pastureland. Hiking, biking all-terrain vehicle use and other recreational uses are allowed and generally not restricted within the watershed. (2000)

<u>Communications</u>

Three DNR communication sites are located west of Lake Whatcom in the planning area. These are identified, from north to south, as Galbraith Mountain, Lookout Mountain and South Lookout (see Map P-1, Appendix C.)

<u>Water/storm water management</u>

Commercial forestry is the primary designated use of the DNR-managed lands in the Lake Whatcom watershed. There is no residential use, which would require a much higher level of management of water and storm water. Residential development is not permitted under current zoning and is not anticipated in the future. DNR's approach to water and storm water management is scaled to meet the needs of the current land use. Refer to the "Water" section for discussions of surface and ground water quality and quantity. DNR addresses storm water management concerns on trust lands through strict adherence to all applicable laws, including the Forest Practices Act and State Environmental Policy Act, as well as department policies.

<u>Sewer/solid waste management</u>

Since most DNR-managed lands in the planning area are designated for commercial forest uses there has been no need for sewer or wastewater planning. Likewise, because of the non-residential uses of these lands, solid waste management needs have been limited to cleanup of unauthorized dumping.